POWER

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Contents for June 30, 1931

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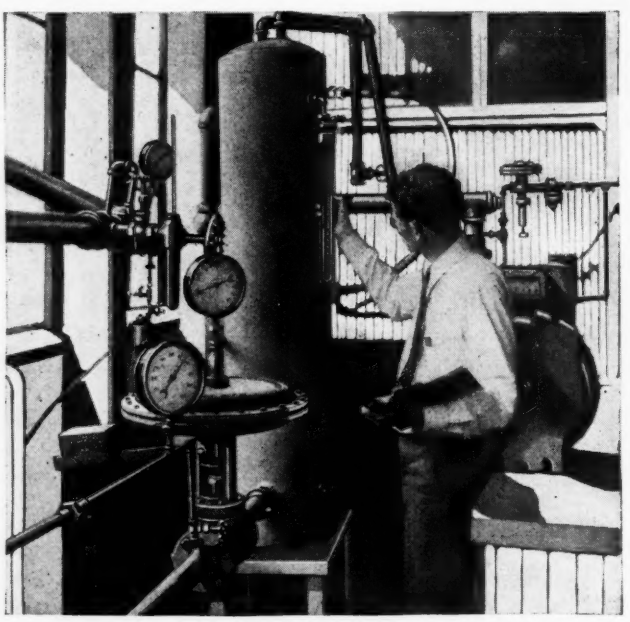

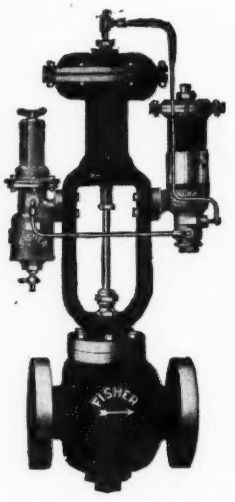

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POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

ELY C. HUTCHINSON, *Editor*

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Distribution

A RECENT bank comment on economic conditions says: "Unemployment undoubtedly presents a problem, but it cannot be solved by any policy that would be disastrous to the industries. If the latter are to assume the responsibility of keeping labor always employed they will have to find the means of doing so by obtaining higher prices for their products or paying lower wages to their employees."

Taking industry by and large, its employees, large and small, are the purchasers of its products.

If the prices of the products are increased or if the amount paid to the mass employee is reduced, the purchasing power of the consumers will be diminished, less product will be required, less employment afforded and less profit made.

Everybody agrees that the problem is one of the distribution of the products of labor, but nobody suggests an industrial model upon which manpower may be adjusted to absorbable production, and the product equitably distributed among those who create it in proportion to the value of their service.

Suppose ten men take five dollars a day apiece out of a business and another man takes fifty. If this little group represents industry as a whole, there must be twice as much taken out in order to pay the high-priced man, than if they all got the same pay.

If the products of industry as a whole were increased in price enough to pay the typically high-priced man, the ability of the others to buy would be proportionately reduced.

The only way to pay higher-priced attaches is to cut costs other than by reducing wages or to make more profit by making more goods than would be normally demanded.

However prodigal they may be, the highly paid personnel can consume only so much of the staple products of industry.

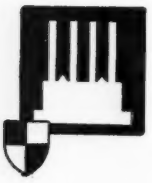
What becomes of the goods which have to be made to pay these salaries?

The producer does not carry his proportion of his particular product home with him, but if he buys less of other things with the money into which it is converted there will be less activity in other lines. If he buys less food and clothing even the railroads and steel mills will be affected.

And Andrew Mellon says that 380,000 people out of 120,000,000 pay 97 per cent of the income tax.

F. R. Low

EDITORIALS



A. S. M. E. Pure Air Committee

BECAUSE of its conviction that the campaign for a cleaner atmosphere has reached permanent and world-wide proportions and because the responsibilities, as they relate to power production and attendant services, must be actively assumed by those whose businesses are directly affected, *Power* has, for more than a year, been calling attention of power producers to a realization of their position.

There are many forms of atmospheric pollution, and some of the worst are entirely outside the field of industrial and utility power production. Yet, and apparently because they are the most tangible and are identified with groups having corporate responsibility, the makers of power are the first to receive attention. They are destined to be targets, and the sooner they all realize and accept their situation the better off they will be.

Smoke, cinders and fly ash are outstanding points of attack. Because public health is involved, the medical men and the women's clubs are heading local movements which promise to make it hard for the power producers. In their ignorance of the technical difficulties, public-spirited organizations are apt to make demands for abatement or complete elimination of these troubles, far exceeding the possibility of practical attainment in the present state of knowledge of fuel burning.

This is evident from the history of legislation to date. There are anti-smoke ordinances of many years' standing that demand a degree of perfection impossible of fulfillment, but bureaus of smoke prevention are nevertheless charged with their enforcement. It is natural, then, that such laws do not receive the cooperation of the power producers. It just cannot be given. Unintelligent demands of health boards and women's clubs must necessarily receive the same apparent lack of response. Then there are other factors in the pure-air problem, such as incinerators, chemical plants, smelters, rubber factories, waste-reclamation plants and so on. Their activities so interlock and cross that it immediately becomes apparent that headway in the major campaign can only be made when they can meet on common ground and plan their procedure with unprejudiced consideration for the interests and problems of each.

The American Society of Mechnical Engineers has recognized these facts in the formation of its newly organized Pure Air Committee. The immediate effect is to give engineering recognition to the problem of air purification.

With its nucleus of representative membership from the National Electric Light Association, American Society of Heating and Ventilating Engineers, the Mellon Institute and the Smoke Abatement Research Department of the Stevens Institute of Technology, a splendid start has been made.

The policy of the committee invites the cooperation of all who are interested in, or affected by, the pure-air movement, and *Power* hopes those in the power field, equipment manufacturers and users alike, will be among the first to accept the benefits of this opportunity.

Improving Power Factor of Building Loads

WITH THE extension of alternating-current systems in office and other buildings, the resulting low power factor is becoming a serious problem, as it has in many industrial plants. Elevators are one of the chief contributors to the difficulty. Changing from rheostatic to variable-voltage control has made the condition worse. With variable-voltage control each elevator has a motor-generator set, usually consisting of a squirrel-cage motor driving a direct-current generator. These units operate at part or no load most of the time and their power factor is lowered accordingly. In some cases static condensers have been used to correct the difficulty. These probably offer the best solution to the problem when it is discovered after the power equipment has been installed; but they may not if all factors are considered in the original design.

Low power factor in a building load is just as objectionable as when found in an industrial plant. Experience has shown that intelligent motor selection combined with correct power system design is the way to avoid low power factor for industrial loads.

The most desirable place to correct low power factor is at the source. Substitution of synchronous motors or synchronous-induction motors for induction types, on

elevator motor-generator sets, is one way of doing this. For industrial purposes this type of motor has been made interchangeable with induction types, and in sizes above twenty-five horsepower they may be started and stopped by push-button control. Improvements in synchronous motor applications such as these include all the elements necessary for elevator variable-voltage-control generator drives. Nevertheless there are other special engineering and economic problems to be worked out before full advantage can be had from this combination. The motors and control equipment will have a higher first cost than the induction type, but the saving from the more efficient power system, the reduction in feeder and transformer capacity and the improved power rates all offer opportunities to compensate for the greater first cost.

Improvement of building-load power factor offers a promising field for investigation. It cannot be solved piecemeal, however, but must take into account power supply, distribution system and application of equipment to obtain the most economical combination.

More Light on Metals For High Temperature

THE American Society for Testing Materials is a great and efficient body for the production of information and standards in a field as broad as industry itself. All materials from silk to steel and from rubber to refractories are its meat. Its hard-working committees have contributed profoundly to industrial progress.

Last week in Chicago the A.S.T.M. joined hands with the A.S.M.E. to study a problem of mutual interest —the effect of temperature on the properties of metals. Metals alone limit the advance of power engineers to higher steam temperatures and resulting higher thermal efficiencies. For help the engineer turns expectantly to the metallurgist.

The Chicago symposium on this subject was notable in several respects. First, no papers were read at the meeting; instead they were printed as a single volume of 620 pages, and distributed well in advance for the careful study they deserved.

At each session the customary ineffective and time-consuming presentation of papers by individual authors was replaced by a single summary of all papers by a committee representative. Thus the road was cleared for ample discussion.

For highly technical subjects, such as those discussed, this method of conducting meetings proved its value. In addition, the clear analysis of power needs in three papers dealing, respectively, with boilers, turbines and piping, and the immense amount of information amassed in the metallurgical papers, showed clearly the advantage gained by combining the forces of the A.S.T.M. and the A.S.M.E. A report of this significant symposium will appear in *Power* next week.

This Year's College Graduate

ENGINEERING EDUCATION was discussed in these columns recently and attention was called to the fact that a market problem is involved. It was suggested that the engineering colleges should consider markets and adjust their supply of graduates to the demand. Admittedly this is difficult when world conditions can change so completely during a student's four-year course. Nevertheless, engineering still has a popular appeal to students, and colleges remain filled despite increased academic requirements.

For several years past the demands of industry for graduates of many of the colleges have exceeded the supply. Recruiting by industries and the availability of jobs have led graduates to expect positions on graduation with minimum effort on their part. But the problem of this year's graduates is different. Many have been unable to secure the type of employment their predecessors have accepted.

As a result of the present world-wide economic situation, those industries which have the best management and can produce in competitive markets at the lowest costs will occupy the strongest position. These ends can be attained only by the employment of keen, industrious and highly trained staffs. Here lies the opportunity for today's graduate.

A man leaving college today not only will find it more difficult to secure a position, but must work hard to hold it. This "school of hard knocks" will bring out the best there is in him and will develop a hard-working, keen and aggressive engineer. The man who makes good under these conditions will be a formidable competitor of those who have gone before, and he will tend to displace the older men who have not learned how to battle against such odds. Depression is an incentive to improvement.

Today's graduate must, therefore, cheerfully attack the problem of making a place for himself with the confidence that real leadership and resourcefulness are still in demand and that the overcoming of present industrial handicaps is a training that will be of inestimable value later in life.

▼

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼

FORD SOLVES HEATING PROBLEM AT DEARBORN

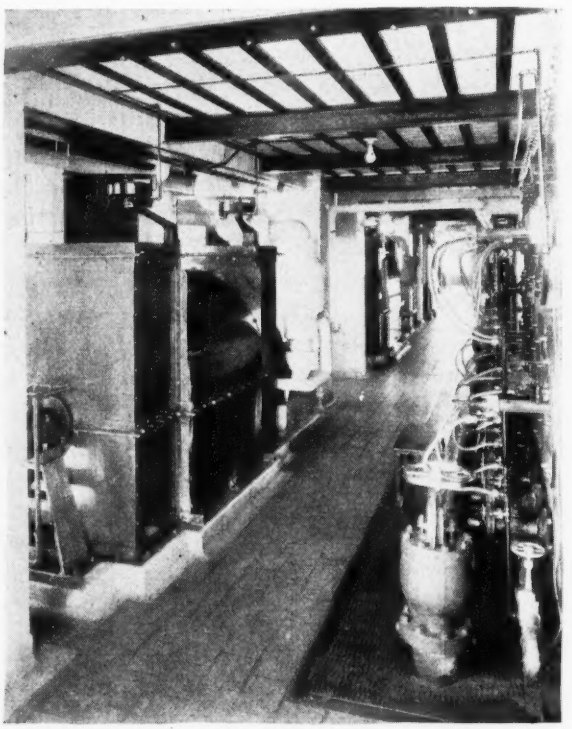
TO THE Ford properties at Dearborn near the experimental building and the engineering laboratory, the recent addition of the enormous industrial museum and technical institute, and the taking over of the services of the airport with its airplane factory, depot and hangars, have so expanded the demands for steam, electrical energy and other services that it has been necessary to rearrange the existing power-plant facilities. Relative locations and proportions of the various building and the interconnection by underground service tunnels appear in the accompanying plot plan.

In replacing an existing boiler plant at the airport, high-pressure steam was needed for process and steam at reduced pressure for an existing forced-circulation hot-water heating system[1]. In the museum high-pressure steam had to be made available for the possible operation of certain exhibits, and, owing to economies that might be effected, it was decided to use it at the supply pressure in the heaters of a forced-circulation hot-water system installed to maintain uniform temperatures. In the engineering laboratory the indirect surface in five fan rooms and the direct radiation around the outside walls called for low-pressure steam, as did the direct surface in the experimental building. Owing to the foregoing demands and the uncertainty of future requirements it was decided to carry high-pressure steam to all buildings and where necessary use reducing stations to lower the pressure. The distances involved made the saving in piping no small item.

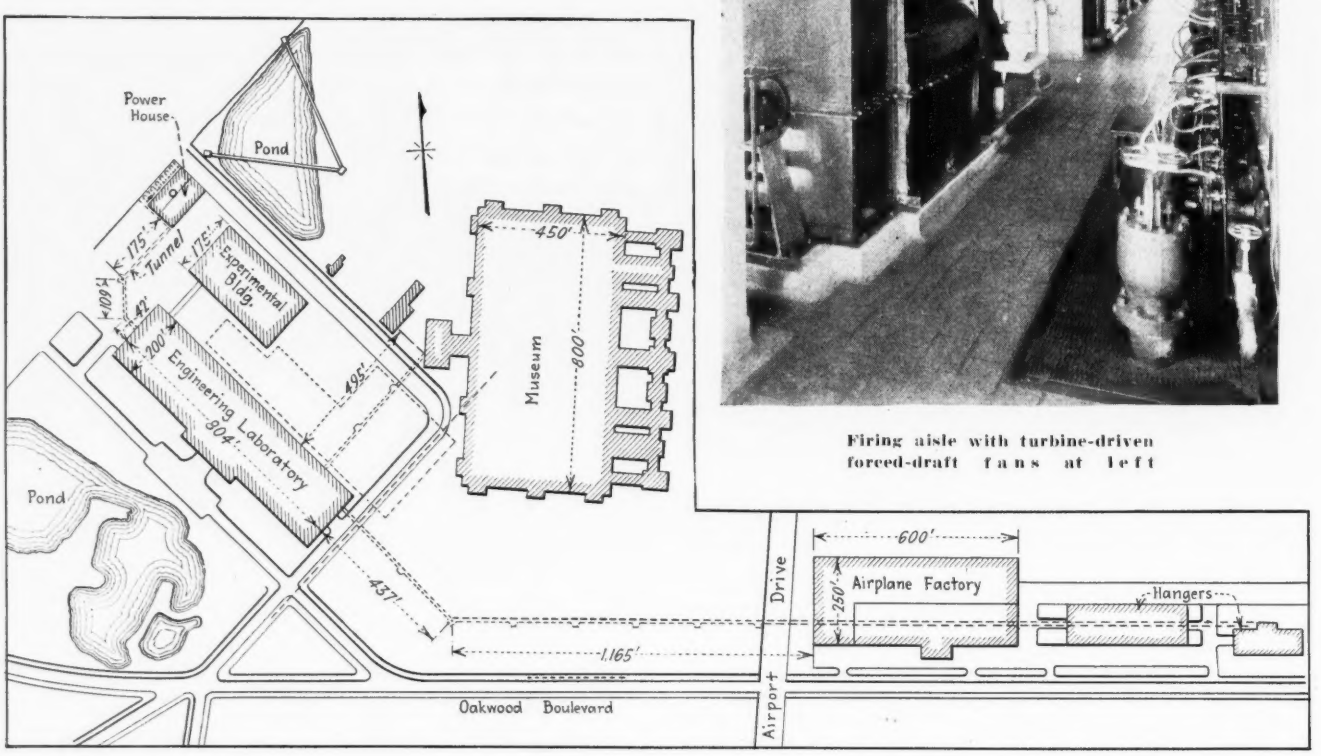
For the present, estimated maximum requirements for steam during the heating season approximate 130,000 lb. per hour. Power and lighting is supplied through high-line service from the Ford Rouge plant or the Detroit Edison system. Equipment retained for emergencies in the older section of the Dearborn power plant consists of four 2,000-sq.ft. oil-fired boilers, a 300-kw. corliss-engine-driven direct-current generating unit, and a 500-hp. Heinrich Lanz German locomobile driving an alternating-current generator. Two motor-generator sets transform the 4,600-volt Rouge service for the direct-current load in the experimental and laboratory buildings. Alternating-current service is supplied to the latter structures.

To meet the enlarged steam demand three new 10,000-

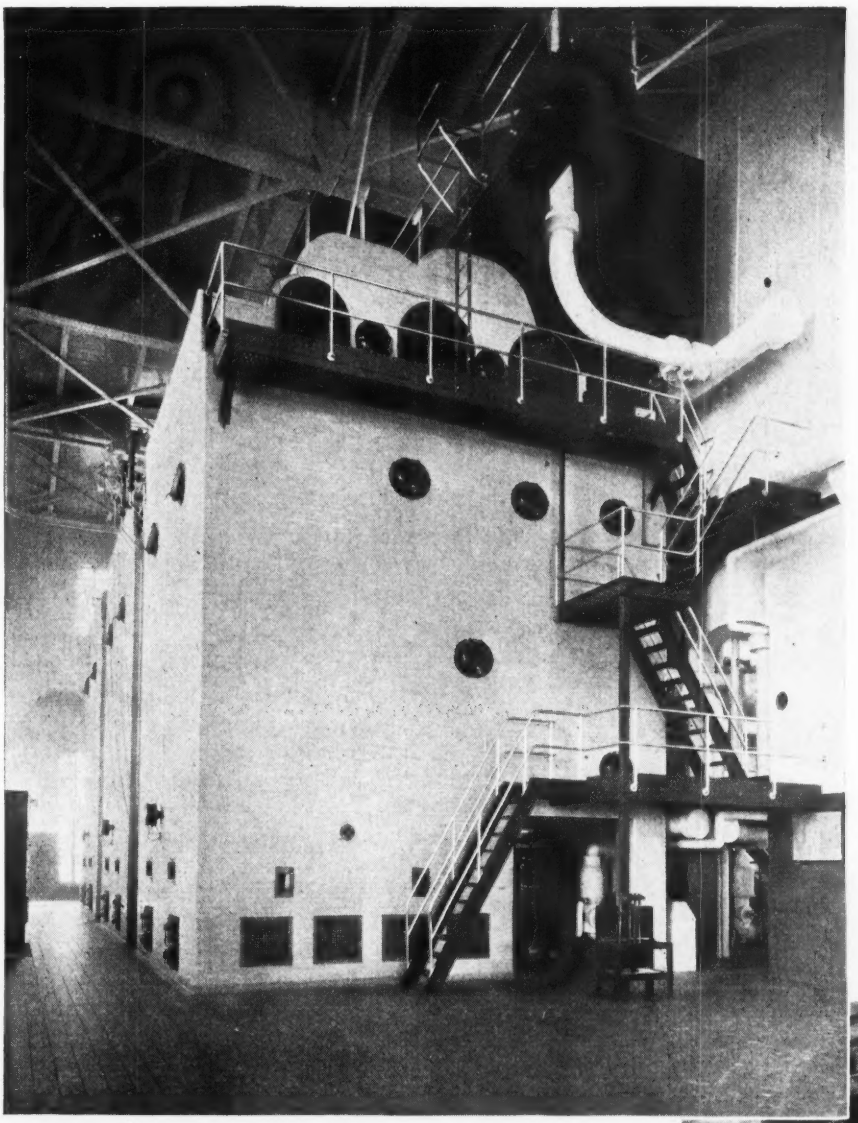
[1]See *Power*, May 19, 1931.



Firing aisle with turbine-driven forced-draft fans at left



Plot plan of Dearborn properties



Interior view of new Ford boiler plant at Dearborn

NEW boiler plant supplies high-pressure steam through service tunnels to the various buildings. Oil is the fuel, but provision also is made for gas. Air-cooled boiler settings of special design are a feature

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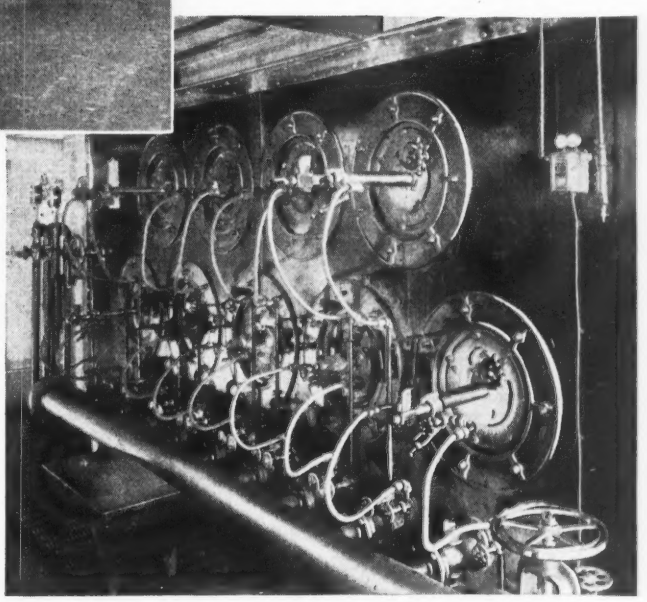
Combination oil-and-gas burner installation serving one boiler



sq.ft. Stirling-type boilers, with space for a fourth unit, were installed in a 37x137-ft. addition to the plant. For uniformity and attractive appearance the entire building is faced with white Indiana limestone. An ornamental stack 14 ft. in diameter and 150 ft. high is arranged for flood-lighting. For the interior, walls and piping painted white, floors and wainscoting of red quarry tile, boiler settings of gray salt-glazed brick with a Terraza base at the floor level, chromium-plated trimmings, valve wheels and railings on stairways and grating platforms giving access to the boilers, and other innovations all present a most attractive appearance.

The boilers face toward the windows, but with the combination oil-and-gas burners serving them mounted on the rear furnace wall and the setting cut in to form a firing aisle under the mud drum, the front wall of each setting is plain except for a central steam pressure gage and the observation and access doors. The water columns are in the outer aisle, also a three-panel gage board, with flush-type indicating and recording steam and air flow and CO_2 meters, and multi-pointer draft gages. The forced-draft fans, one per boiler, are in the firing aisle opposite the burners. They are of the double inlet type, turbine driven, and rated to deliver individually 37,000 cu.ft. of air per minute.

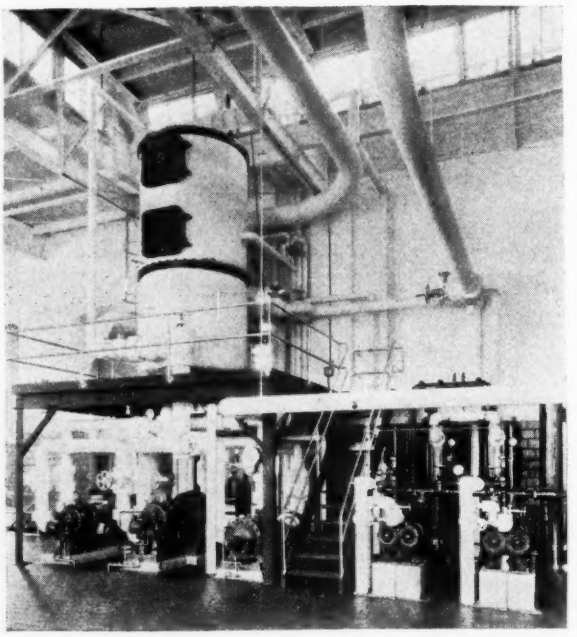
Steam is generated at 175 lb. pressure, although the boilers are designed to withstand a steam pressure of 275 lb. City water of excellent quality is used, so that no softening equipment is required. Returns from the various buildings come back to an open deaërating heater of 240,000 lb. per hour capacity, with extra storage space underneath. The heater is mounted on a platform raised eight feet above the floor. Underneath are three centrifugal boiler-feed pumps, two having a capacity of 400 g.p.m., and the other rated to deliver 250 g.p.m. One of the larger pumps is motor-driven and the drives for the other two are steam turbines. Exhaust steam from these pumps, the fan turbines and the oil pump is avail-

able for use in the heater. Make-up is admitted to the heater under float control. The feed to the boilers is controlled by water-level regulators.

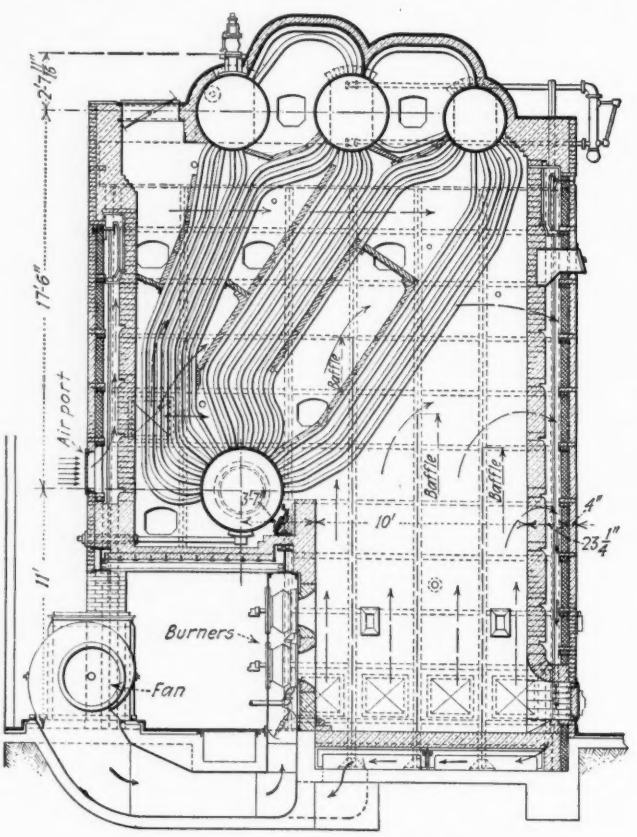
A feature of the boilers is the design of the settings. As shown in an accompanying sectional view, the construction is of the sectional suspended hollow-wall type. Cooling air is admitted through four bronze-grille inlets at the bottom of each side wall and two similar air ports in the rear wall. The flow in the side walls is upward through passages formed by vertical baffles of increasing height from front to rear. At progressive elevations, therefore, the air turns over the tops of the baffles to the front wall. From the rear wall the air passes along the uppermost sections of the side walls to the front. Thus all air admitted to the wall spaces eventually passes downward in the front wall and under the floor of the furnace into ducts leading to the respective double-inlet fan serving the boiler.

Discharge from the fan is downward through a duct leading to the dampered inlet of the burner windbox, in which a static pressure of 3 in. of water is maintained. Tempering dampers at the top of the inlet casings of the fan, under the control of thermostatic regulators, limit the air temperature to 220 deg., which is attained when boiler operation is carried to 200 per cent rating. When this temperature is exceeded at the fan inlet the dampers automatically open and admit cooler, tempering air from the boiler room.

Nine high-pressure combination oil-and-gas burners serve each boiler. Oil, the present fuel, is maintained at a pressure of 225 lb. at the burner by either one of two direct-acting steam pumps under control of pump governors. Relief valves discharging back to the suction prevent excess pressure. Two live-steam heaters, used in series, parallel or singly, as desired, raise the temperature of the oil to 200 deg. Visual evidence of the temperature and the pressure is given by a thermometer and a gage in the supply to each set of burners. The quantity of oil used by the nine burners serving each boiler is controlled by either one of two valves, one in the return from the burners to the main return header, and the other in a bypass around this valve. The setting of either one of these valves determines the amount of oil circulated back, usually to storage, but in the present case to the suction of the fuel oil pumps. This practice was adopted to avoid the drop in oil temperature occasioned from a return to storage. To prevent the return oil at 200 deg. temperature from breaking the suction of the pumps, a positive head of 10 lb. is maintained on the suction line by a steam-driven booster pump drawing from storage.



Feed-water heater, with boiler feed pumps underneath; to the right are the fuel oil pumps and oil heaters



Section through boiler setting

In a tunnel separated by a wall from the boiler room basement are nineteen 6,500-gal. oil tanks. They are connected in five groups of three and one group of four tanks to a common suction header from which the booster pump draws the supply needed for immediate use. Directly above the tanks a railway sliding permits gravity transfer from tank car to storage. Six gages in the boiler room, graduated in gallons, show the amount of oil available at any time in each of the six groups of tanks.

Operation carried on in the new boiler plant during the past winter has not taxed its capacity. For the greater part of the time the exceptionally mild weather has permitted one boiler to carry the load. Requirements were below average, so that in future heating seasons it is expected two boilers will be needed to carry the load, leaving one in reserve, with space for another unit to care for possible additions that may become necessary at some future time.

Albert Kahn, Inc., of Detroit, was architect and engineer on this work.

Boiler Feed Water Analyses and Their Interpretation

By J. D. YODER
Water Softener Division
Cochrane Corporation, Philadelphia

A WATER ANALYSIS is a statement of the mineral and organic substances dissolved in the water. From the standpoint of boiler feeding and other industrial purposes, excepting the preparation of food products, the most important constituents are the mineral solids, the organic solids being of importance only indirectly as they are related to foaming and priming. An analysis of water for boiler feed or industrial use, therefore, consists primarily of a statement of the mineral solids dissolved and suspended in the water, with a further statement of the volatile and organic matter, without specifying what the organic matter is.

The Fundamental Ionic Analysis

Chemists generally favor reporting the metals and acid radicals as they are determined in the laboratory, without attempting to combine them in the forms in which they would be likely to be deposited if the water were evaporated to dryness. Analysis A is a typical example.

ANALYSIS A—REPORTED IN IONIC FORM

	Parts Per Million	Grains Per U.S. Gal.
Calcium (Ca)	62	3.62
Magnesium (Mg)	31	1.81
Sodium (Na)	37.7	2.20
Iron oxide and alumina	3.6	0.21
Silica (SiO_2)	18	1.05
Bicarbonate (HCO_3)	250	14.59
Sulphate (SO_4)	138	8.05
Chloride (Cl)	11	0.64
Volatile and organic	56	3.27
Total solids by evaporation	480	28.00
Suspended matter	238	13.89
CO_2 (free)	16	0.93
	1341.3	80.26

This method of reporting analyses has the advantages of simplicity, ease of comparing mineral solids quantitatively with those reported in other analyses and avoidance of errors in working out combinations. It has the disadvantage that it does not of itself characterize the water with respect to its suitability for boiler feed. Without a knowledge of the equivalent combining weights of metals and acid radicals, the engineer would not know whether the water would be likely to deposit hard calcium sulphate scale in the boilers, a rather soft carbonate scale or merely a soft sludge.

Analysis Reported in Combined Form

This form of report also does not show the ratio of sodium sulphate to sodium carbonate to be expected upon concentration in the boiler, which is of value in estimating embrittling properties. These disadvantages are overcome by reporting the analysis combined in such a manner as the metals and acid radicals would most likely combine to form boiler scale upon evaporation of the water to steam in the boilers. Analysis B results from combining the metals and radicals reported under Analysis A.

ANALYSIS B—ANALYSIS A REPORTED IN COMBINED FORM

	Parts Per Million	Grains Per U.S. Gal.
Calcium carbonate	78	4.55
Calcium sulphate	105	6.13
Magnesium carbonate	107	6.24
Silica	18	1.05
Iron oxide and alumina	4	0.23
Sodium sulphate	94	5.44
Sodium chloride	18	1.05
Volatile and organic	56	3.27
Total solids by evaporation	480	28.00
Suspended solids	238	13.89
Free carbon dioxide	16	0.93
	1214	70.78

This method of reporting analyses is frequently preferred by the engineer, who may or may not have a knowledge of chemistry, since it presents a fairly clear picture of the character of the solids that are likely to be deposited in the boiler, and therefore better indicates the importance of feed-water treatment.

A disadvantage of reporting analyses in the combined form is that there is lack of agreement, and probably never will be complete agreement, among chemists as to the proper manner of making the combinations. This results in the same analysis being reported differently by different chemists, which is frequently very confusing to the engineer and is at all times confusing if analyses made of the same water supply by different chemists are to be compared. For the foregoing reasons, neither of these methods completely meets the requirements nor is likely to be adopted generally as standard.

Ionic Report With Equivalents

A third form of analysis is to supplement the statement of the metals and radicals, as given in Analysis A, by their equivalents, which reduce all of the constituents to a common denominator or into units of equivalent value. The equivalents may be stated as parts per million or grains per gallon. If the analysis is reported in parts per million, the parts per million of the substances divided by their equivalent weights give the equivalents per million.

This form of analysis, with equivalents, has all the advantages of that shown in Analysis A, and by making use of a few simple principles all the advantages of Analysis B. It also holds out promise of general adoption as the standard method for reporting water analyses, having already been favorably commented upon by com-

mittees of several important technical societies. This method is illustrated by Analysis C.

ANALYSIS C—IONIC ANALYSIS A REPORTED WITH EQUIVALENTS

	p.p.m.	eq.p.m.
Calcium (Ca)	62	3.10
Magnesium (Mg)	31	2.54
Sodium (Na)	37.7	1.63
Iron oxide and alumina	3.6	.....
Silica (SiO_2)	18	0.60
Bicarbonate (HCO_3)	250.1	4.10
Sulphate (SO_4)	138	2.87
Chloride (Cl)	11	0.31
Volatile and organic	56	....
Total solids by evaporation	480	....
Suspended matter	238	....
CO_2 (free)	16	0.72

When the equivalents are given, it is only necessary to apply certain simple rules to understand the character of the water, as follows:

Rule 1—(Ca eq. + Mg. eq.) greater than (HCO_3 eq. + CO_3* eq.) indicates permanent hardness proportional to the excess.

Rule 2—(Ca eq. + Mg eq.) equal to (HCO_3 eq. + CO_3* eq.) indicates that all the hardness is temporary, with no excess sodium carbonate. This will produce a carbonate scale more easily removed by turbine cleaners than if the water contained some permanent hardness as in Rule 1.

Rule 3—(Ca eq. + Mg. eq.) less than (HCO_3 + CO_3* eq.) indicates an excess of sodium carbonate proportional to the difference. Such a water commonly produces sludge and not boiler scale.

Rule 4—H indicates the presence of free acid or acid properties.

In applying these rules to Analysis C it is evident that (Ca eq. + Mg eq.) is 5.64, which is appreciably greater than the HCO_3 eq. (4.10). This indicates that the water contains moderate permanent hardness. If it is desired to know the total hardness in terms of calcium carbonate, this is easily determined by multiplying the (Ca eq. + Mg eq.) by 50, which is the equivalent weight of calcium carbonate.

For convenience in determining the equivalents when analyses are given in the uncombined or combined forms, as well as for determining the proper amount of chemicals to use for treatment, the table on this page lists the elements and substances frequently appearing in the chemistry of water softening, with their formulas and molecular and equivalent weights. Some substances have more than one equivalent weight, depending upon the substances with which they react. The equivalent weights given in the table apply to the reactions of water treatment.

Before proceeding, the conception of equivalent weights as used in this table should be more clearly explained. It will be noted from the table that the equivalent weight of hydrogen is 1, or the same as its atomic weight. The equivalent weight of other substances, compounds or elements is the weight which takes the place in compounds of one atom of hydrogen.

For example, the molecular weight of the radical CO_3 is 60. One radical molecule of CO_3, however, combines with two atoms of hydrogen, so that the amount combining with one atom of hydrogen is 30, which then becomes the equivalent weight.

Sulphuric acid, similarly, has an equivalent weight of 49.05, its molecular weight being 98.1, as it contains two atoms of hydrogen. When combined with calcium to form calcium sulphate, one atom of calcium takes the

*CO_3 is rarely found in a raw water unless contaminated by factory waste.

TABLE OF MOLECULAR AND EQUIVALENT WEIGHTS OF ELEMENTS, COMPOUNDS AND RADICALS

Substance	Formula	Weight of Molecules or Radicals	Eq. Wt.
Aluminum	Al	27.1	9.03
Alum. sulphate (crystal)	$Al_2(SO_4)_3.18H_2O$	666.7	111.12
Alum. sulphate (anhydrous)	$Al_2(SO_4)_3$	342.4	57.07
Ammonium alum	$Al_2(SO_4)_3(NH_4)_2.SO_4.24H_2O$	907.1	151.18
Potassium alum	$Al_2(SO_4)_3K_2SO_4.24H_2O$	942.2	157.03
Aluminum hydrate	$Al(OH)_3$	78.1	26.03
Aluminum oxide	Al_2O_3	102.2	17.03
Sodium aluminate	$Na_2Al_2O_4$	164.2	27.36
Barium	Ba	137.4	68.70
Barium carbonate	$BaCO_3$	197.4	98.70
Barium chloride	$BaCl_2.2H_2O$	244.3	122.15
Barium sulphate	$BaSO_4$	233.5	116.75
Calcium	Ca	40.0	20.00
Calcium bicarbonate	$Ca(HCO_3)_2$	162.0	81.00
Calcium carbonate	$CaCO_3$	100.0	50.00
Calcium chloride	$CaCl_2$	110.9	55.45
Calcium hydrate (Pure)	$Ca(OH)_2$	74.0	37.00
Calcium hydrate (90%)	$Ca(OH)_2$	.....	41.00
Calcium oxide (Pure)	CaO	56.0	28.00
Calcium oxide (90%)	CaO	.....	31.10
Calc. sulphate (anhydrous)	$CaSO_4$	136.0	68.00
Calcium sulphate (gypsum)	$CaSO_4.2H_2O$	172.1	86.05
Calcium nitrate	$Ca(NO_3)_2$	164.1	82.05
Iron (ferrous)	Fe''	56.0	28.00
Iron (ferric)	Fe'''	56.0	18.66
Ferric oxide	Fe_2O_3	160.0	26.66
Ferrous sulphate	$FeSO_4.7H_2O$	278.0	139.00
Magnesium	Mg	24.4	12.20
Magnesium oxide	MgO	40.4	20.20
Magnesium bicarbonate	$Mg(HCO_3)_2$	146.4	73.20
Magnesium carbonate	$MgCO_3$	84.4	42.20
Magnesium chloride	$MgCl_2$	95.3	47.65
Magnesium hydrate	$Mg(OH)_2$	58.4	29.20
Magnesium nitrate	$Mg(NO_3)_2$	148.4	74.20
Magnesium phosphate	$Mg_3(PO_4)_2$	263.1	43.85
Magnesium sulphate	$MgSO_4$	120.4	60.20
Manganese chloride	$MnCl_2$	125.9	62.95
Manganese hydrate	$Mn(OH)_2$	89.0	44.50
Potassium	K	39.1	39.10
Potassium iodide	KI	166.0	166.00
Silver chloride	AgCl	143.3	143.30
Silver nitrate	$AgNO_3$	169.9	169.90
Silica	SiO_2	60.4	30.20
Sodium	Na	23.05	23.05
Sodium bicarbonate	$NaHCO_3$	84.6	84.60
Sodium carbonate	Na_2CO_3	106.0	53.00
Sodium chloride	NaCl	58.5	58.50
Sodium hydrate	NaOH	40.1	40.10
Sodium nitrate	$NaNO_3$	85.0	85.00
Tri-sodium phosphate	$Na_3PO_4.12H_2O$	380.4	126.90
Di-sodium phosphate	$Na_2HPO_4.12H_2O$	358.2	119.46
Mono-sodium phosphate	$NaH_2PO_4.H_2O$	138.1	46.03
Meta-phosphate	$NaPO_3$	102.1	34.03
Sodium sulphate	Na_2SO_4	142.0	71.00
Sodium thio-sulphate	$Na_2S_2O_3$	158.2	79.10
Sodium tetra thionate	$Na_2S_4O_6$	270.3	135.15
Acid Radicals:			
Bicarbonate	HCO_3	61.0	61.00
Carbonate	CO_3	60.0	30.00
Carbon dioxide	CO_2	44.0	22.00
Chloride	Cl	35.45	35.45
Iodide	I	126.9	126.90
Nitrate	NO_3	62.0	62.00
Hydrate	OH	17.0	17.00
Phosphate	PO_4	95.0	31.66
Phosphorous oxide	P_2O_5	142.0	23.66
Sulphate	SO_4	96.06	48.03
Acids:			
Hydrogen	H	1.0	1.00
Acetic acid	$HC_2H_3O_2$	60.4	60.40
Carbonic acid	H_2CO_3	62.0	31.00
Hydrochloric acid	HCl	36.45	36.45
Phosphoric acid	H_3PO_4	98.0	32.66
Sulphuric acid	H_2SO_4	98.1	49.05
Manganous acid	H_2MnO_3	104.9	52.45

Many power engineers do not realize that the so-called "analysis" of the water showing amounts of various compounds present is a convention only. The chemist generally does not know what compounds are present in a solution. What his analysis really discloses are the amounts of various metals, acid radicals and alkaline radicals. An "ionic" analysis listing these is sufficient for practical purposes if supplemented by equivalents from which the character of the water is obvious upon inspection, as explained in this article

place of two atoms of hydrogen, so the equivalent weight of calcium is 20, its molecular weight being 40.

In treating water with lime and soda ash by the hot-process system, it is not necessary to feed lime for free CO_2 or to give an excess hydrate radical, but it is advisable to feed approximately 25 p.p.m. of excess sodium carbonate ($1\frac{1}{2}$ gr. per gallon) or 0.47 eq.p.m. The amount of chemicals required for treatment is easily determined by the following rules, in all cases working with the eq.p.m.:

(HCO_3 + Mg) × equivalent weight of lime (90 per cent calcium hydrate) = pounds lime required per million pounds water.

(Ca + Mg + 0.47 — HCO_3) × equivalent weight of soda ash (sodium carbonate) = pounds soda ash required per million pounds of water.

Applying these formulas to Analysis C, we have:

(4.10 + 2.54) × 41.10 = 273 lb. commercial lime per million pounds of water, or 2.26 lb. per 1,000 United States gallons.

(3.10 + 2.54 + 0.47 — 4.10) × 53 = 106 lb. soda ash per million pounds of water, or 0.88 lb. per 1,000 United States gallons.

Converting Combined Analysis to Ionic Form

One of the uses of the table is to convert an analysis in the combined form into an ionic analysis. The procedure is simple. For example, Analysis B gives 78 p.p.m. of calcium carbonate, the equivalent weight of which is 50. Dividing 78 by 50 gives 1.56 eq.p.m. Similarly, there are 105 parts of calcium sulphate, the equivalent weight of which is 68. Dividing 105 by 68 gives 1.54 eq.p.m. Adding 1.56 to 1.54 gives 3.10 eq.p.m. Multiplying this by the equivalent weight of calcium, which is 20, gives 62 p.p.m. of calcium as in Analysis A.

ANALYSIS D—TYPICAL WATER TREATED BY HOT-PROCESS SOFTENER

Combined Form	p.p.m.	gr./US gal.	Ionic Form	p.p.m.	eq.p.m.
$CaCO_3$	9	0.52	Ca	3.6	0.18
$MgCO_3$	3	0.17	Mg	1.0	0.08
SiO_2	11	0.64	Na	39.1	1.68
R_2O_3	1	0.06	CO_3	21.0	0.70
Na_2CO_3	23	1.34	SO_4	35.0	0.73
Na_2SO_4	52	3.03	Cl	18.7	0.52
NaCl	31	1.81	R_2O_3	1.0	0.06
Vol. org.	20	1.17	Vol. org.	21.0	....
Tot. sol.	150	8.75			

In this way Analysis A may be obtained from B. To obtain B from A requires certain assumptions regarding the sequence of combinations. These rules have no fundamental significance except as a means of estimating the quantities of the several compounds which will remain after complete evaporation in the laboratory and to indicate the character of the water as boiler feed. For the purposes of the boiler operator nothing can be done with the resulting "combined" analysis that could not be done equally well, or better, with the ionic analysis, and these rules are therefore of little practical value to anyone except chemists whose clients demand analyses in the historic combined form.

The parts per million and equivalents per million may be converted to grains per United States gallon and equivalents per United States gallon by dividing by 17.12 or by multiplying by 0.0583. The following conversion factors will frequently be found useful:

Lb. per M. ÷ 120 = Lb. per 1,000 U. S. gallon.

Lb. per M. ÷ 100 = Lb. per 1,000 Imperial gallons.

P.p.m. × 0.0583 = Grains per U. S. gallon.

P.p.m. × 0.0486 = Grains per Imperial gallon.

Analysis D illustrates the general appearance of analyses, in both the combined and ionic forms, of typical waters treated by a hot-process softener.

It is well to keep in mind that a guarantee of 2 gr. per gallon of calcium and magnesium salts (1.25) gr. per gallon calcium carbonate and 0.75 gr. magnesium carbonate) would be the equivalent of 8.6 p.p.m. calcium (Ca) and 3.6 p.p.m. magnesium (Mg).

It is frequently stated that a hardness of 1 gr. of calcium carbonate and 0.5 gr. magnesium carbonate is typical of what may be expected with $1\frac{1}{2}$ gr. excess sodium carbonate. This would be equivalent to:

	p.p.m.	eq.p.m.
Ca	6.8	0.34
Mg	2.4	0.20
CO_3	30.6	1.02

The sodium is not specified because it will be quite variable, depending upon the SO_4 and Cl present, the amount of which is not an indication of the performance of the softener, but is entirely determined by the character of the raw water.

▼ ▼ ▼

GETTING READY TO PAINT

The following comments relating to the preparation of under-water steelwork for painting are from a committee report of the Canadian Electrical Association:

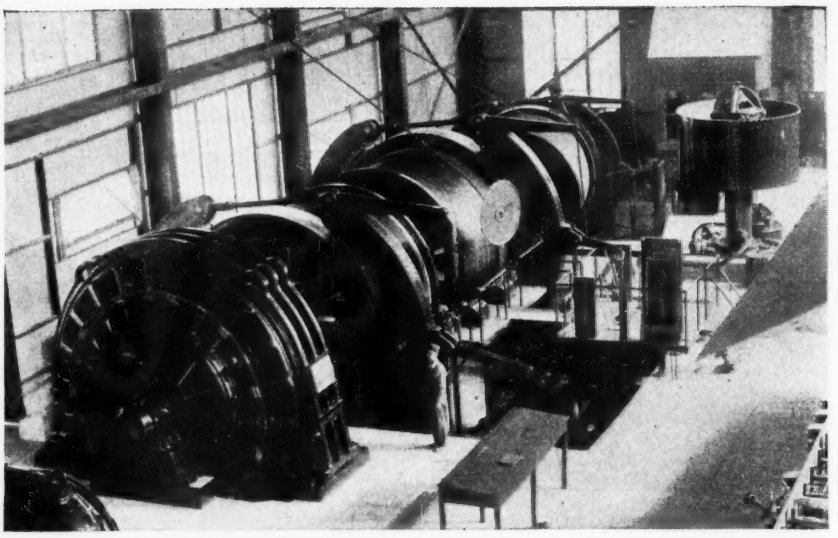
On new work it is practically impossible to remove all mill scale (magnetic iron oxide), owing to its adhesive qualities. Surfaces must be cleaned of rust and lightly adhesive scale, before applying paint, and grease must be removed completely.

Sandblasting is effective on both old and new work, but usually expensive.

Most isolated plants must rely upon inexpert labor for the application of paint, and it is therefore doubly important to insist upon careful expert inspection of both prepared surface and the painting process.

Few novices realize the importance of a completely dry surface for the application of paint. A steel surface may apparently be dry but actually covered with a fine film of moisture, and the only sure way to remove this is to heat the metal a few degrees above the surrounding temperature and maintain it at such higher temperature for some time before applying paint.

Tools for removing rust are fine and coarse-steel wire brushes and triangular ship scrapers, which must be kept thoroughly sharpened for effective and economical work. Sandblasting also is used. Flattened old bent files, specially shaped and sharpened, are useful for removing rust from corners and irregular positions, rivets, etc.



Brakes on this electrically driven mine hoist are released by oil under pressure and applied by gravity

BRAKES for Motors and Their Loads

A great amount of data is available on starting motors and running them to suit the particular application. However, very rarely does one see or hear anything about the stopping of motors. This article explains the means of retarding, stopping and holding motors under various conditions of operation.

By H. M. FRENCH
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ELECTRIC BRAKING includes the retarding in speed, the bringing to rest, and the holding of a motor and its load. These functions may be accomplished either by a friction braking device electrically released, or, except for the last, by an electrical braking system. Electric braking of motors may be accomplished in two ways: (1) by electro-mechanical means, that is, the brake is controlled by electricity but performs its braking function mechanically; (2) by strictly electrical means, that is, where electric current alone is used. Under the first heading may be listed friction brakes held in release by solenoids, magnets or by a motor-operated device. Under the second heading comes dynamic braking, regenerative braking and plugging.

For a long time all forms of braking in which electric current was applied directly to a motor to effect a slowing down were called dynamic braking. However, in the last few years, the term has come to mean only one form; while the terms regenerative braking and plugging embrace two other forms of braking. As used here, dynamic braking means only a form of braking where the motor to be controlled is made to operate as a generator, converting the stored energy into electricity dissipated as heat from a resistor. In regenerative braking the motor operates as a generator and its output is fed into the supply line as useful energy. Plugging consists of applying current to a running motor opposite to the direction of rotation, and slowing it down or stopping it by reverse torque, but without actually causing the motor to run in the reverse direction. The energy is dissipated in a resistor connected in series with the armature. These forms of braking will be discussed in more detail further on.

Friction brakes, for the most part, are used for stopping and holding motors and their driven loads, and, in special forms, can be used for speed-controlling and retarding service. Friction brakes are made in three forms: shoe, band and disk. A shoe-type brake, Fig. 1, consists of a wheel against which two shoes are pressed by a weight or spring. The shoes are lined with a suitable friction material and adjustment is provided to compensate for wear. A band brake, Fig. 2, uses a lined steel band which incircles the wheel and is operated in the same manner as the shoe brake. A disk brake consists of one or more disks keyed to the motor shaft, against which anchored disks are pressed by springs. The number and size of disks used are determined by the braking torque required. Release is effected by a magnet.

Magnets for friction brakes may be wound for either alternating or direct current. Direct-current magnets

may be either shunt- or series-wound, depending upon the type of direct-current motor with which they are used. The series-wound brake is the safest, since the magnet can be energized only when current is flowing in the motor which will sustain the load. If the shunt wound brake is used, it may be possible to energize the magnet without applying power to the motor. A series brake is more rapid and more positive in its action than a shunt-wound brake. Alternating-current brakes are always shunt-wound, and their action is as rapid as the direct-current series-wound type.

The torque capacity of a motor can be found from the formula:

$$\textit{Torque}\ (\text{in ft. lb.}) = \frac{5{,}250 \times \textit{Hp.}}{\textit{Full-load speed}\ (\text{in r.p.m.})}$$

A brake's holding torque is usually made equal to the rated torque on cranes and similar equipment in order that it will hold any load that the motor can lift and have

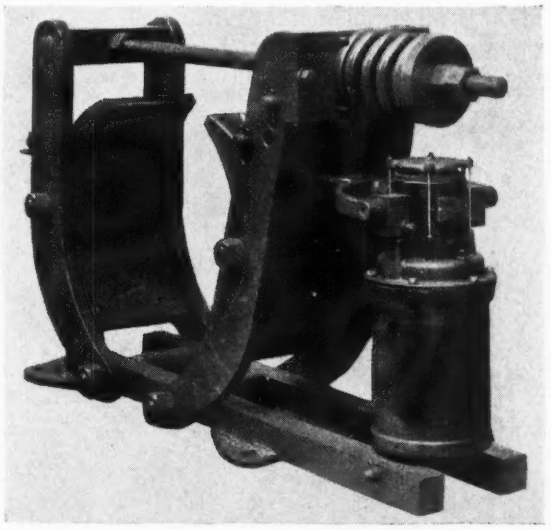

Fig. 1—Thrustor-released, spring-set, alternating-current brake having a maximum torque rating of 6,000 foot-pounds

a safety factor, as the crane friction helps the brake but opposes the motor. On other applications, such as larry cars, the brake-holding torque is generally less than the motor torque, to prevent too rapid a rate of "deceleration" and the possibility of locking the wheels when stopping.

Solenoid-Load Brakes

A discussion of friction brakes would be incomplete without a description of the solenoid-load brake. This is a gravity-applied, solenoid-release, shoe brake used only with wound-rotor induction motors, and differs from the regular solenoid brake by having two solenoids. It enables the operator to lower loads safely at constant reduced speeds and also acts as a holding brake.

Cranes and hoists in general require an automatic-load brake to prevent excessive lowering speeds, and also a solenoid brake to hold suspended loads. Before the advent of the solenoid-load brake, automatic mechanical-load brakes were commonly used for this service. However, because of the continual wear on the brake when lowering, frequent manual adjustments were required to keep the brake in successful operation. All the energy of the descending load plus some from the motor has to be absorbed in the brake, causing excessive heat and wear. The solenoid-load brake, on the other hand, provides for regenerative braking except while retarding or while inching the load. This reduces the heat and wear on the brake shoes and reduces maintenance and adjustment.

For the sake of clarity, the two solenoids of the solenoid-load brake will be referred to as the connected solenoid and the floating solenoid. The connected solenoid is connected across one phase of the stator winding of the motor and exerts a retarding torque of 35 per cent of the full-load torque of the motor. The floating solenoid is connected in series with the resistor across one phase of the rotor windings and has a retarding torque of 90 per cent of the motor's full-load torque.

When the controller is turned to the first point lowering, power is applied to the motor stator, which acts as a transformer and induces current in the rotor. The floating solenoid thus becomes energized and tends to raise its core, reducing the braking effect. The connected solenoid, however, is not energized and the braking torque remains high. If the torque of the load plus that of the motor is sufficient to overcome the brake friction, the load will start down with a speed dependent upon the weight on the hook. If the load is insufficient, the second point on the controller must be used.

The third and fourth points simply provide a higher lowering speed. The fifth point energizes the connected solenoid and entirely releases the brake. The remaining points of the controller allow the motor to run as a generator, putting power back into the system and providing regenerative braking.

This type of brake is particularly applicable in foundries, machine shops and on erecting work. With it, it is

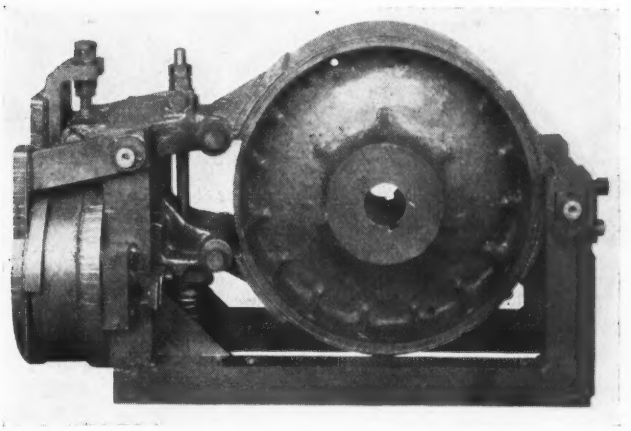

Fig. 2—Spring-set, clapper-magnet-released, band-type direct-current brake

possible to jog the motor 0.05 of a revolution, which for a 30-ft.-per-minute hoist and a 1,200-r.p.m. motor, means that the hook will move only $\frac{1}{64}$ of an inch.

Briefly summarized, the advantages of solenoid load brakes are: (1) reduction of adjustment and maintenance; (2) economy of power lowering because of the regenerative action of the motor; (3) saving of space and weight by replacing two devices with a single unit; (4) provision of creeping speeds for precise handling of loads.

There has recently been introduced for use with direct-current motors a line of magnetic brakes, Fig. 2, which have certain definite advantages over solenoid-operated brakes. These are spring-set, magnet-released, band-type brakes designed primarily for heavy-duty, such as that of cranes, hoists, steel mill auxiliaries and similar applications.

The brake band is held set by a heavy spring. When

power is applied to the motor, it energizes the magnet and draws the movable plate, or clapper, over against it and releases the brake. When the power is cut off, the spring applies the brake through a powerful toggle action. The wear on this type of brake is small, because 90 per cent of the wheel surface is used for braking, thus reducing the pressure on the braking material to approximately 15 or 18 lb. per square inch. Braking is positive in either direction of rotation.

On the larger sizes of alternating-current, spring-set brakes the solenoid may be replaced by an electro-hydraulic device called a thrustor, Fig. 1. This device consists of a vertical oil cylinder and piston, with a motor-driven impeller in the piston. This impeller pumps the oil from above the piston to below, setting up a

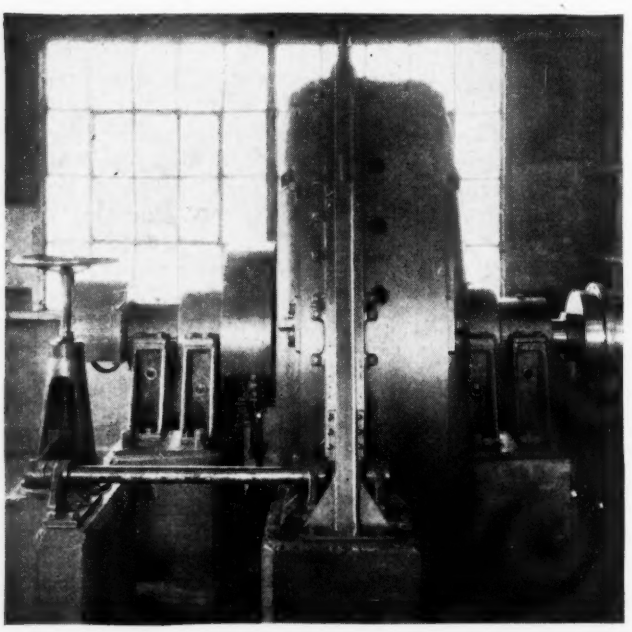

Fig. 3—A brake is used to start this synchronous motor

Both the stator and rotor are mounted in bearings. When power is first applied to the motor at starting the stator is free and comes up to synchronous speed with the rotor at standstill. The brake is then gradually applied and as the stator slows down, the rotor and its connected load come up to speed.

strong upward thrust. The driving motor, either alternating- or direct-current, is a fractional horsepower unit and drives the impeller through a splined telescoping shaft. When the motor is stopped the piston sinks to the bottom of the cylinder.

When applied to a brake the energizing of the main motor also starts the thrustor motor, and the brake is jacked open against its spring or weight. The thrustor motor continues to run as long as the brake is released. When the main motor is deenergized the thrustor motor coasts to rest and the piston sinks, allowing the brake to reset. The brake application is smooth, there being no tendency to chatter or grab.

By adding a small flywheel to the thrustor motor, the time of coasting to rest can be increased, which results in a slower application of the brake. This feature is useful where the load quickly comes to rest without the brake and the brake has to serve only as a holding device, or where a descending load must not be stopped so suddenly as to strain, for instance, derrick rigging.

It is impossible in an article of this kind to go into any detailed discussion of brake linings. In general, asbestos is the material used for linings, although leather or wood are sometimes used. In the February, 1931, number of the *Iron and Steel Engineer* there is a very comprehensive discussion of brake linings and wheels.

Strictly electrical systems of braking can be used only for reducing or holding constant the speed of a motor that is being overhauled by its load. Where it is necessary to stop and hold the load a friction brake must also be used. Dynamic braking involves controlling the speed of a motor that is being overhauled by allowing it to run as a generator and dissipating the energy as heat in a resistor.

This system of braking is used on both alternating-current wound-rotor and on direct-current motors, although a separate source of direct current of proper voltage must be provided to obtain dynamic braking from alternating-current motors.

Regenerative Braking

Regenerative braking is similar to dynamic braking except that the motor being overhauled generates power, at line voltage, which goes back into the line as useful energy. It is an inherent feature of alternating-current motors that they will regenerate power only at speeds above synchronism, while with direct-current motors, by

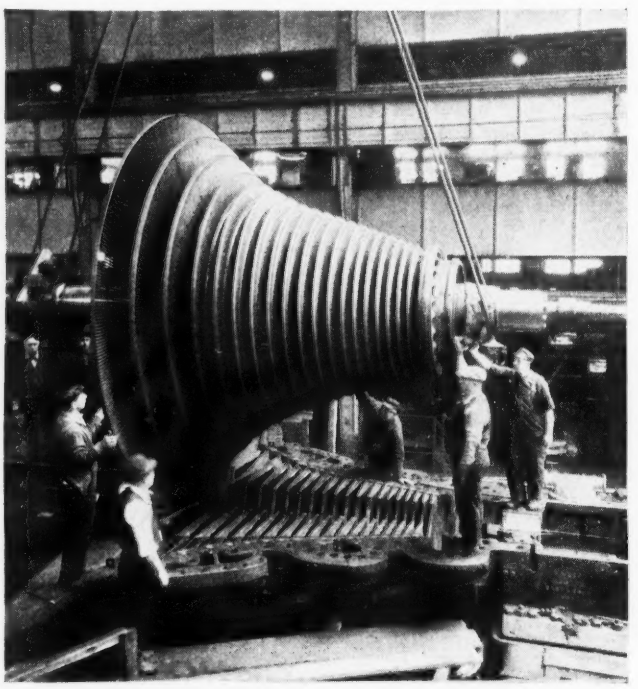

Fig. 4—An 80,000-hp. steam-turbine rotor being lowered by a crane on which the braking must be precise to avoid serious damage

varying the field strength, the regenerative action can be maintained at considerably reduced speeds. It is thus apparent that with direct-current motors both regenerative and dynamic braking may be used to reduce the speed to a point where a friction brake may safely be applied. With alternating-current motors regenerative braking can only be used for lowering at a constant speed just above synchronism, and other means must be used to retard to any lower speed.

Plugging is a system of braking wherein two leads to the motor being overhauled are reversed, setting up a torque in a direction counter to the normal motor torque. The effect is to bring the motor to rest or to a very slow speed, when a friction brake can be applied. This system of braking works equally well with either alternating- or direct-current motors. Plugging is most generally used with reversing drives.

Pointers on Burning Refinery Fuels

By F. J. McDEVITT
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THE BOILER PLANT is the heart of an oil refinery, and most operators prefer to have at least two units in reserve. Using 75 to 90 per cent raw water, properly treated, the boilers can be operated continuously at 300 per cent rated capacity and up to 400 per cent on peak loads. On this basis a 5,500-sq.ft. boiler works in nicely. Smaller units have too narrow furnaces for the loads imposed, and from flame impingement are subject to undue maintenance on the side walls.

Heat liberation in the furnace should be kept at about 15,000 B.t.u. per cubic foot per hour. Then, with the active combustion taking place in the lower portion of the furnace the upper front wall is free to impart radiant heat to the boiler tubes. A bent-tube design of boiler offers good possibilities for this arrangement. The center line of the mud drum should be set at least 20 ft. above the floor. The front wall should be of solid refractory and the lower side walls water-cooled, using about 16 ft. as the distance between headers. Providing a solid refractory dutch oven at the rear of the furnace makes possible the use of a long flame without impingement.

Cross-Jet Air Admission

Admission around the burners is the conventional method of supplying air for combustion. It may be drawn in from the room or forced in through a windbox surrounding the burners. In either event the flow is parallel to the fuel stream. This method of introducing the air lends itself to stratification and long flame travel. Cross-jetting of the air under high velocity into the fuel stream gives quicker and more intimate union of the particles of carbon and oxygen. No general rule can be laid down regarding the application of the air, because the arrangement varies with type of boiler and design of furnace. The air nozzles should be so arranged, at different points in the furnace, to give penetration and at the same time impart a progressive rotation or swirling to the fuel stream. Best results can be secured by treating each installation as a separate problem.

Furnaces equipped with cross-jet air nozzles are particularly suitable for the burning of low-grade fuel oil and pulverized coal or coke, as the air breaks up the fuel stream, causing extreme turbulence and reducing the long flame travel at high ratings. Auxiliary valves should be provided to regulate the air at the different points of admission. Preheating the air will improve the results. It is possible to operate at all times, regardless of the fuel used, within 1 per cent of the theoretical CO_2.

Objection is sometimes made to the use of fuels like acid sludge on account of the sulphur content. If the furnace is first started on gas, and transfer then made to acid sludge, no trouble will be experienced, provided the exit gases are kept above the dew point. When taking the unit out of service, gas should again be fired for a while to drive out all sulphurous fumes.

Consistency of acid sludge varies considerably. In heavy form it may be burned in a rotary kiln. Benefit is derived from the combustion of the volatile matter, but a large portion of the fixed carbon is not consumed. Acid sludge in a lighter form is sometimes mixed with low-grade fuel oil and burned in steam-atomizing burners. The latter should be designed to pass solid particles without clogging, and the flame should be snuffed out when the atomizing steam exceeds 2 per cent. The fuel mixture should be heated to at least 150 deg. by steam coils located in the storage tank. Where difficulty is experienced with the heavier particles settling in the tank it is sometimes advisable to increase the circulation by using a motor-driven impeller located tangentially inside the tank. The main oil piping should loop back to the tank, with auxiliary loops at each boiler. Avoid all dead ends, for they will plug up. Have the centrifugal fuel oil pump designed for 100 lb. pressure and arranged to circulate at least three times the quantity required by the burners at maximum rating. An auxiliary containing good fuel oil should be installed for emergency use.

Handling Petroleum Coke

Petroleum coke can be delivered from the stills or storage to the boiler plant in side-dump cars, and dumped into a track hopper. The top of the track hopper should be equipped with a grizzly to catch the wire that is often imbedded in the coke. The coke can be reduced to $\frac{3}{4}$ in. by a crusher located below the track hopper, and, by an apron conveyor equipped with a magnetic separator to catch the tramp iron, can be transferred to a combination bucket and belt conveyor for delivery to the overhead bunker. Each boiler should have a separate self-cleaning coke bin and automatic weighing scale arranged to feed the coke to a unit pulverizer. The pulverizer should be on a mezzanine floor with a short-coupled bottom connection to a single burner. This arrangement gives a clear roomy firing aisle, and also tends to eliminate surging in the burner. Coke frequently runs high in moisture, which increases the power requirements on the unit mill and under abnormal conditions causes clogging or choking. By providing each boiler panel with a bell and red light, advance notice can be obtained of an increase in power consumption. Upon receiving the warning, it is the operator's duty to avoid a choke by reducing the coke feed to the mill.

Petroleum coke handles satisfactorily in pulverized form. Power requirements and mill maintenance are lower than with most coals. The ash content is almost neglible, and the fusing point is about 2,600 deg. No difficulty is experienced from slag. When the coke has an oily binder, care should be used in supplying preheated primary air to the mill.

Any furnace using refinery fuels may be subject to an explosion. To prevent damage to the setting, the access doors in the side walls should be of the explosion type and in sufficient number to relieve immediately any undue pressure in the furnace.

To prevent cracks in the brickwork, a setting of the size previously indicated should have several rows of horizontal buckstays surrounding the furnace and tied into the boiler columns. Staggered expansion joints packed with loose asbestos should be provided at the four corners of the setting throughout the entire height.

When selecting a water wall, do not install too much heating surface. Bear in mind that petroleum coke is low in volatile matter, and the furnace must have sufficient temperature to maintain ignition.

Valves and Boiler Fittings for 1,900 Lb. and 900 Deg.

By BRUNO BELOHLAVEK
Engineer in Charge of High-Pressure Boiler Design
Vitkovice Steel Works, Czechoslovakia
and ARTHUR J. HERSCHMANN
U. S. Representative of Vitkovice Steel Works

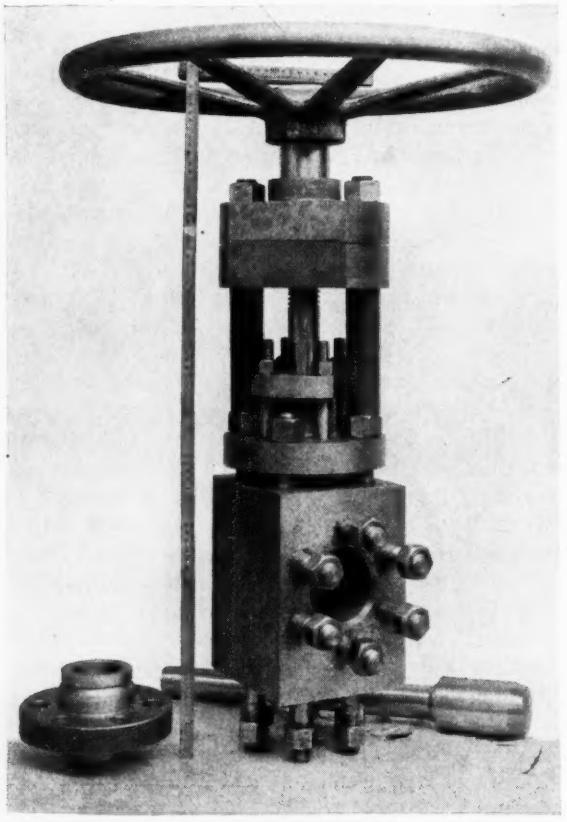


Fig. 1—Right-angle stop valve, 60 millimeter clear (2.36 in.)

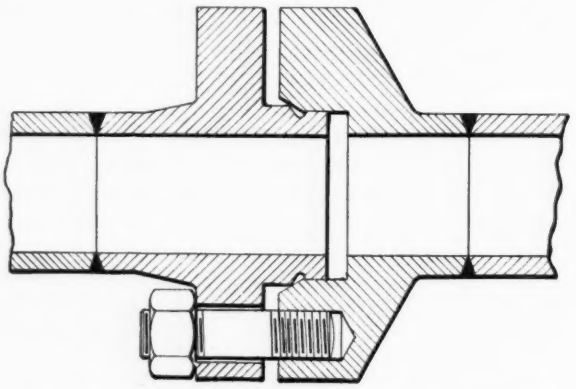


Fig. 2—Pipe joint. Edge of inner cone is deformed by pressure thus producing a hermetic seal

DEVICES which this article describes have been in constant operation on all Loeffler boilers for several years and have proved entirely satisfactory. The late professor Stephan Loeffler, who designed the Loeffler steam-pumping generator in 1923, developed steam control elements along new lines.

The starting point for these was the steam-tight joint shown in Fig. 2. Professor Loeffler first applied this joint to his flanged pipe connections. Pressure applied in tightening this joint squeezes the sealing edge of the inner cone into the hollow cone so that it suffers a slight deformation. This joint forms a hermetic seal which has proved faultless in its application to pipes of both small and large size. It is a reliable element of design which also underlies the construction of the various Loeffler valves.

All Valves Use Sealing Cones

Fig. 3 shows the Loeffler right-angle valve. Pressure exerted by the valve spindle forces cone *a* into hollow cone *b* and seals at circumferential edge *c*.

Valve housing *d* is cut from a solid block of steel. Pipe connections are made by high-pressure flanges designed as previously explained. These flanges have tubular extensions bevelled for oxy-acetylene welding to the pipe. The stuffing box of the valve is so arranged that it remains relatively cool. The valve-stem nut is solid with the hub of handwheel. When the valve is opened the spindle rises into the hollow of that hub. The nut rotates in a ball bearing firmly bolted to the valve housing. "Vitko" S.O. steel of 78,000 to 92,000 lb. tensile strength is used in these forged housings, while cone *a* and its mate *b* are made of non-rusting steel.

For the control of main steam lines these Loeffler highest-pressure valves have a diameter considerably smaller than that of the pipe, thereby greatly reducing the cost of the valve.

The transition from valve to pipe is made by means of two conical attachments, with the result that an almost complete conversion of velocity head into pressure energy is effected. Toggles, arranged to preclude binding, transmit the closing pressure of the vertical slide to the valve proper.

Straight-Flow Valves with Toggle Action

Valve spindle *a* (Fig. 4) is guided and kept from turning by rollers *b* rotating on pins *c*. These pins also carry links *d* which straddle the horizontal block *g*. That block, by means of bolt *h*, carries (with some slack) vertical disk *i*. To close the valve the spindle is lowered. The block *g* transmits the horizontal component of the downward force to valve disk *i* through follower piece *k*. The cone edge of disk *i* is thereby pressed into the hollow cone of the valve as before mentioned.

It is important to repeat that this design leaves to the closing valve disk perfect freedom to move in all direc-

tions and to follow expansion and contraction which temperature changes may cause. When opening the valve block *g* is pulled toward the valve spindle and that movement is continued until the bore in the bottom extension of the block is adequately accessible to the steam to conduct it to the exit of the valve. The steam has therefore ample passage when the valve is fully open, so that pressure-absorbing losses of eddying steam are avoided.

The increased velocity of the steam which passes through the contracted opening of the valve represents no loss, because the exit cone of the valve is shaped so that the velocity head is reclaimed as pressure energy. Valve disk *i*, the inserted exit cone, pins *c* and the rollers *b* are of non-rusting steel. The solid-forged valve housing, the valve spindle, stuffing box and its superstructure are of hard S.M. carbon steel.

Fig. 4 shows a standard forged-steel Loeffler through-valve for 1,900 lb. working pressure and 932 deg. F. total temperature. Fig. 5 shows a cast-steel valve with the same size of steam passage. Comparative calculations have shown on frequent occasions that there is little difference in cost between the forged valve and that of cast steel. The latter may therefore receive preference only for very large valves. These Loeffler valves have heretofore been built up to a diameter of $3\frac{9}{16}$ in. Such a valve will serve a steam pipe $7\frac{1}{2}$ in. diameter, which is sufficient for 300,000 lb. of steam per hour at a velocity of 7,870 ft. per minute. This corresponds to approximately 40,000 kw. in energy, based on 8.8 lb. steam per kilowatt hour.

If we compare such a condition with that obtaining where the steam pressure is only 220 lb. and the total temperature 662 deg. F., we find that the latter steam condition would require a valve of fully $23\frac{1}{2}$-in. diameter, or two $16\frac{3}{4}$-in. valves.

These Loeffler stop valves have been free from trouble in continuous service of several years and they are now

With the advent of high-pressure high-temperature steam, designers of valves, water columns and pipe connections face new and difficult problems. The solutions worked out in connection with the Loeffler boiler will likely be of interest to many American engineers

so thoroughly tested and perfected in detail that they may be expected to give many years of service under pressure of 1,900 lb. and 932 deg. F. The wear of individual parts, such as rollers, pins and valve disks, and of the path of the rollers, is insignificant with proper selection of materials.

Fig. 6 shows an angle stop valve which may also serve as a throttle valve. It differs from the angle valve of Fig. 3 because its spindle carries a throttling cone *b* besides closing edge *c*. This cone is covered with stellite to minimize wear caused by throttling. The corresponding valve seat *a* is made of non-rusting steel. When closed, the valve spindle seats the valve upon edge *c*. When the spindle is raised, the valve opening can be gradually increased from "cracking open" to "full open."

Non-Return Valves

Fig. 7 shows a check valve for 4-in. clear diameter where the valve disk is held to the seat by a spring. During normal operation the pressure of that spring is, of course, overcome by the steam, which lifts the disk and makes room for its flow. The valve housing is made out

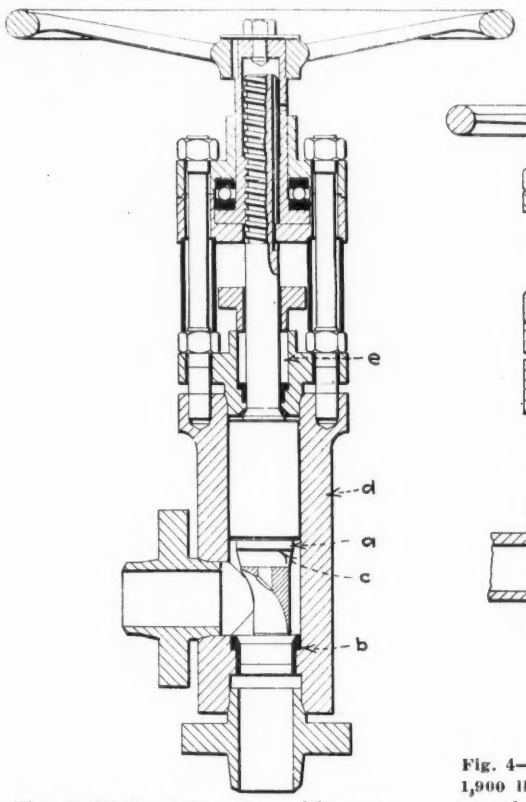


Fig. 3—Right-angle valve with cone seal similar to that shown in Fig. 2

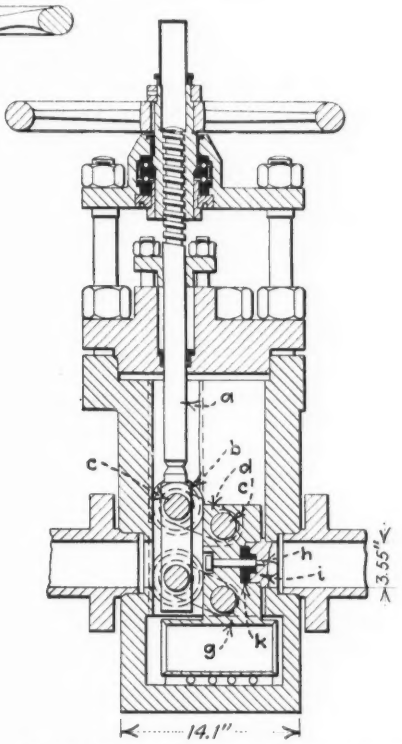


Fig. 4—Forged-steel through valve for 1,900 lb. and 932 deg. F. Valve disk moved by toggle joint in pressure chamber

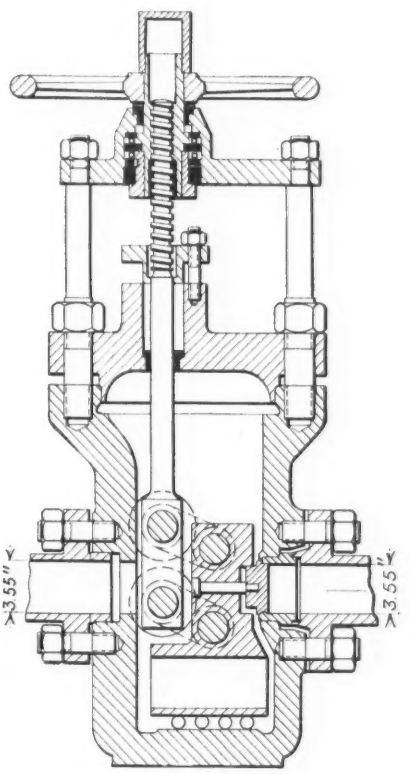
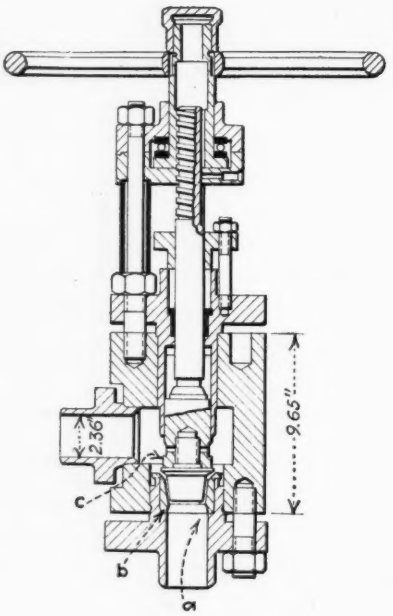
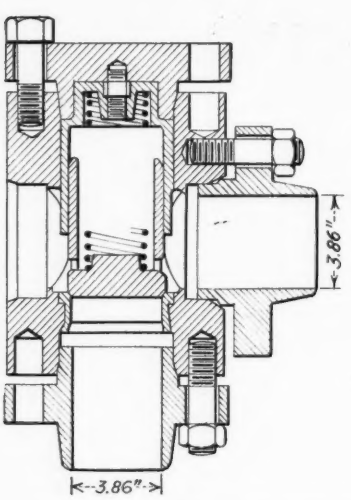


Fig. 5—Valve like that of Fig. 4 but of cast steel





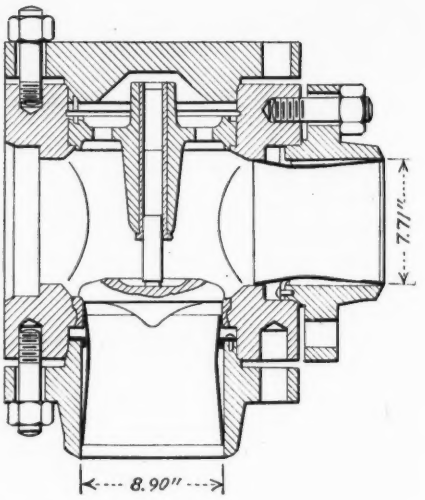


Fig. 6 (Left)—Combined angle and throttle valve

Fig. 7 (Center)—Spring-loaded non-return valve

Fig. 8 (Right)—Large unloaded non-return valve with sheet metal protecting funnels on inlet and outlet

of a block of forged steel, and the pipe connections are made as previously explained. The disk part of the valve is guided to assure free movement without binding.

A non-return valve of large dimension is shown in Fig. 8. It has no check spring and can be used only in a vertical position. Steam connections of these return valves are made tight by cone edges as before mentioned. The sheet-metal funnels inserted in the valve cover the cone-edge joints and protect them against injurious effects of sudden temperature changes. It was found that without these sleeves the edges of the sealing cones would warp with rapid fluctuations of steam and cause blowing at the joints.

Multiple-Disk Lever Safety Valve

For highest pressure it was found necessary to deviate from the ordinary construction of safety valves to avoid undue load concentration. The valve was therefore split up into many valves of small size.

Fig. 9 shows the Loeffler multiple-disk high-pressure safety valve as used on 100,000 lb. per hour boilers operating at 1,900 lb. and 932 deg. F. Six 0.86-in.-opening valves were found necessary. They are arranged in one solid block of forged steel, so that only one steam supply is required. The valve seats are pressed into the housing and, to prevent dislodging, they are secured by circumferential welding.

The individual valves are guided at their lower ends by sleeves of non-rusting steel. They are loaded by weights suspended from the levers by carefully made knife edges. The housing is covered by a cast-iron hood whence a pipe leads the steam outside the boiler house. The housing is made of hard S.M. carbon steel of 78,000 to 92,000 lb. tensile strength.

Available designs of water gages, notwithstanding their recent improvements, were found unsatisfactory for pressures in excess of 1,500 lb. Even the best designs which use glass or similar material were rejected. It was thought that the strongest practicable glass would be attacked and destroyed by the action of steam of highest pressure. Even a relatively slight attack of the glass would greatly impair visibility.

Water-Level Indicator

Professor Loeffler, to obviate these difficulties, designed a water-level indicator of the float type. Experimentation and practical experience during years of use have so improved the device that it is now entirely reliable and safe in operation. The indicating end of the device can be made visible in different ways. By cooperation with the firm of Siemens & Halske an electrical indicator was developed which uses an iron core as a counterbalancing weight for the float. As the float rises the weight goes down, and vice versa. The core moves within a substantial bronze tube which, in turn, rests within a solenoid. A current of constant strength flows through the solenoid winding, and the intensity of that current is changed as the core moves. The current is

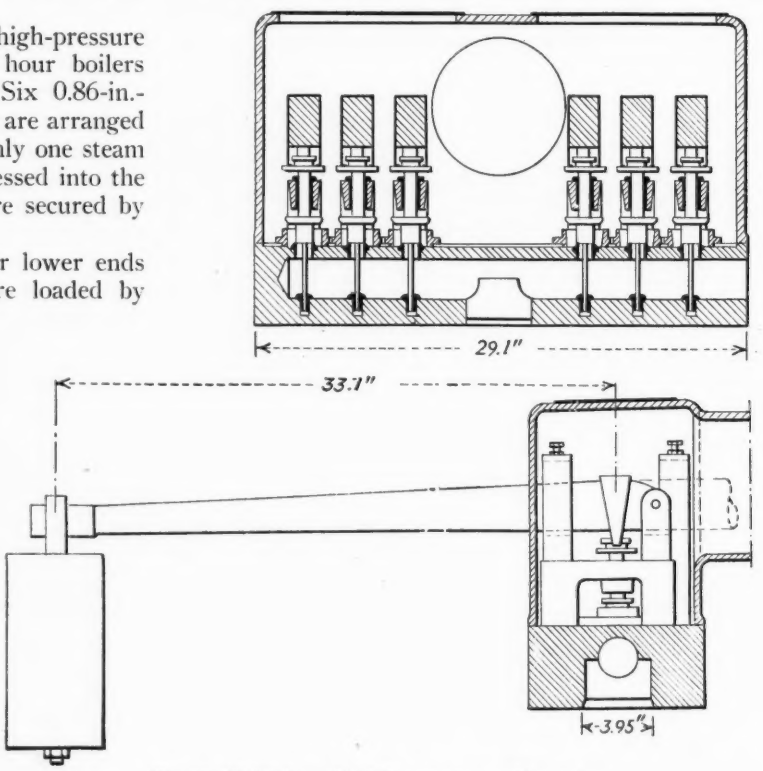


Fig. 9—Multiple-unit high-pressure safety valve

transmitted to an electrical measuring instrument, and the corresponding recording instrument on the board indicates the exact level of the water. This construction has been in use for many years in Austria, also in Czechoslovakia, and will undoubtedly be retained.

There is another way to indicate the position of the float. Instead of the soft iron core, a permanent magnet is suspended as counterweight to balance the float, again moving within a solid bronze tube. The bronze tube in this case is within a housing which carries indicating flaps such as are used on annunciators. As the magnet moves it actuates the flaps and, correspondingly, by the signs which they thus expose, indicates to the attendant the water level with sufficient accuracy.

The latter construction has the disadvantage that it gives a mirror picture of the water level. In other words, if a flap becomes visible above the normal line of water

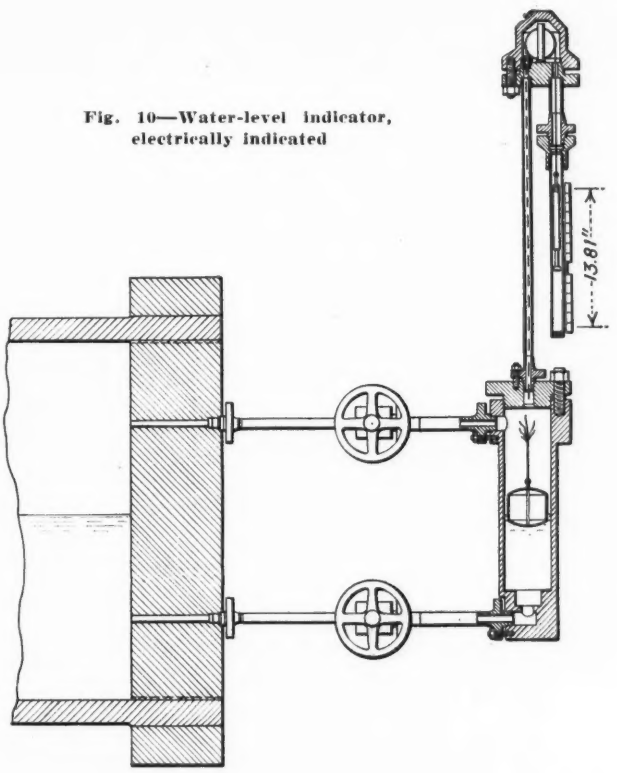


Fig. 10—Water-level indicator, electrically indicated

level on the gage the water level on the boiler has actually become lower, and vice versa. The advantage, on the other hand, is greater simplicity and reliability.

It is the present practice to use both devices on Loeffler boilers, so that they check one another. The float, as also its housing, the top sheave and the counterweight, is in both cases alike in substance and constitutes the orginal design of Dr. Loeffler. The housing (Fig. 9) is made out of a solid steel forging and has an opening for the steam at its top and for the water below. Both openings are $\frac{7}{8}$ in. in diameter. Connection to the boiler drum is made with cone-edge flanges.

The float is of S.M. steel. To prevent collapse it is filled with a liquid which evaporates during operation and creates a relieving pressure on the inside. The float connects with the magnet by means of a special cable which passes over the sheaves without special guide, which could offer frictional resistance. The sheave itself moves without appreciable friction.

To sum up, it may be stated that no difficulties are now experienced with the appurtenances which this article describes.

Motors Resynchronize Automatically

By CARL C. NELSON

Control Engineer
Electric Machinery Manufacturing Company

IN THE EARLIER APPLICATIONS of synchronous motors they sometimes pulled out of step and stopped because of a sudden peak load or a momentary voltage drop that reduced the torque. In addition to production interruption, which in special processes probably caused considerable loss, the field coils were sometimes damaged by roasting by reason of the motor standing still with exciting current in them. The number of interruptions became so great in some instances as to cause users to prefer induction motors. However, plant owners were aware of the high efficiency and controlled power-factor advantages of synchronous motors and so were reluctant to displace them.

The advent of the frequency-relay field-responsive method of synchronizing not only gave improved synchronizing characteristics but inherently provided automatic resynchronization of synchronous motors if they pulled out of step. When the synchronous motor is subjected to a sudden peak load or its torque is reduced by low line voltage to where it pulls out, the frequency relay automatically causes the field switch to open, removing excitation and simultaneously short circuiting the field coils through their discharge resistor. The motor then operates as an induction motor, and when the peak load is removed or the voltage restored to the correct value the motor pulls back into step. It is, of course, essential that the motor has sufficient pull-in torque to bring its load into synchronism, or be provided with an automatic unloader that will allow the motor to pull into step without load.

The frequency-relay field-responsive synchronizing method includes equipment for synchronizing and for excitation removal, which operates as a function of the speed. Thus the control operates to remove excitation only when the motor has desynchronized, whether the pulling out of step was caused by a sudden peak load or a line-voltage fluctuation.

The frequency-relay field-responsive synchronizing system has demonstrated its usefulness in synchronous motors. One installation recently, made on existing equipment where there were numerous shutdowns because of the motor's pulling out of step, practically eliminated the interruptions and showed the practicability of synchronous motors operating on power systems subject to voltage fluctuations.

▼ ▼ ▼

A LARGE DEGREE of the stability shown by the central station industry in recent months is due to the remarkable increases in domestic consumption of electricity. For the first four months of the year, consumption of electricity in American homes was 8.5 per cent higher than for the same period in 1930. It was 24.5 per cent higher than for the first third of 1929. This increase in domestic use has largely offset the falling off in electric power used by factories, mines, and in general industrial operations.—From report of P. S. Clapp at N.E.L.A. Convention, Atlantic City.

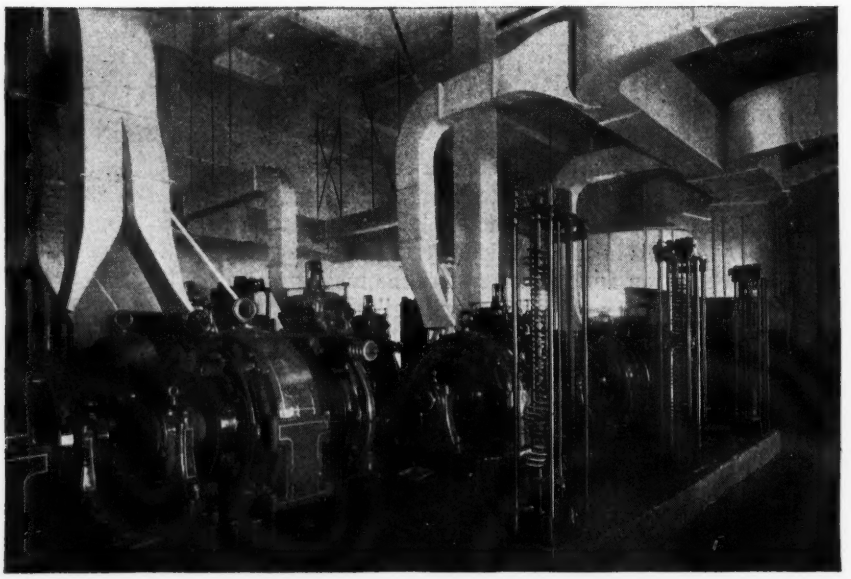


Fig. 1 — Express elevator-machine room in Garment Center Capitol Building, New York City, showing part of the ventilation system

By JAMES K. CAMPBELL
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New York City

Forced Ventilation Cools Elevator-Motor Rooms

Many elevator-machine rooms in large buildings are so located and constructed that forced ventilation must be applied to keep the motors and control equipment temperature within safe limits. How this is done in a number of elevator installations is shown here

HIGH TEMPERATURES found in many elevator-machine rooms not only endanger the life of electrical insulation but also interfere with those who have to inspect, maintain and repair the equipment. Bad as this condition has been in the past, modern high buildings with inside machine rooms have aggravated the situation.

In modern elevator installations, heavy masses involving many times the weight of the passenger load are accelerated and retarded rapidly, necessitating the conversion of large amounts of energy. Practically all of this energy, except the negligible amount which may be pumped back into the mains by regenerative braking, is eventually transformed into heat in the elevator-machine room.

At first thought it may seem impossible that a highly developed mechanism like a modern elevator should have an over-all efficiency little better than zero, yet such is the case. This fact may be explained by an analysis of the actual work performed by the elevator. The useful work consists entirely of raising persons to the upper floors, which results in storing up potential energy. Later these persons are lowered to the street level, and although regenerative braking is used, only a negligible amount of power is pumped back into the line. The greater proportion of this reverse power is absorbed in the apparatus. The potential energy stored up by the hoisting operation is therefore largely dissipated as heat in the elevator-machine room. As a result the heat to be dissipated from an elevator-machine room is about the equivalent of that represented by the power input to the elevator equipment.

One frequently sees figures stating the number of kilowatt-hours per car-mile required to operate a particular type of elevator under certain definite conditions. For instance, a high-rise elevator on express service may run 30 miles per day, requiring an input of 4 kw.-hr. per car-mile, or a total of 120 kw.-hr. per hour, which is equivalent to approximately 40,000 B.t.u. per hour per 10-hr. day. All this heat must be dissipated in the elevator-machine room, since the over-all efficiency of the system is practically zero. In a recent installation where the equipment was designed for a duty of 3,000 lb. at 800 ft. per minute, the heating effect was calculated as 60,000 B.t.u. per hour or 1,000 B.t.u. per minute for 10 hr. for each high-rise express elevator.

In a set-back type of building it is usual to find the low-rise elevator equipment crowded into rooms in the interior of the building on intermediate floors, many feet from an outside wall where the heat may find a natural outlet. When such installations have been made without adequate provision for ventilation, successful operation has been found impossible in the extreme temperatures that have occurred. Among other bad effects has been

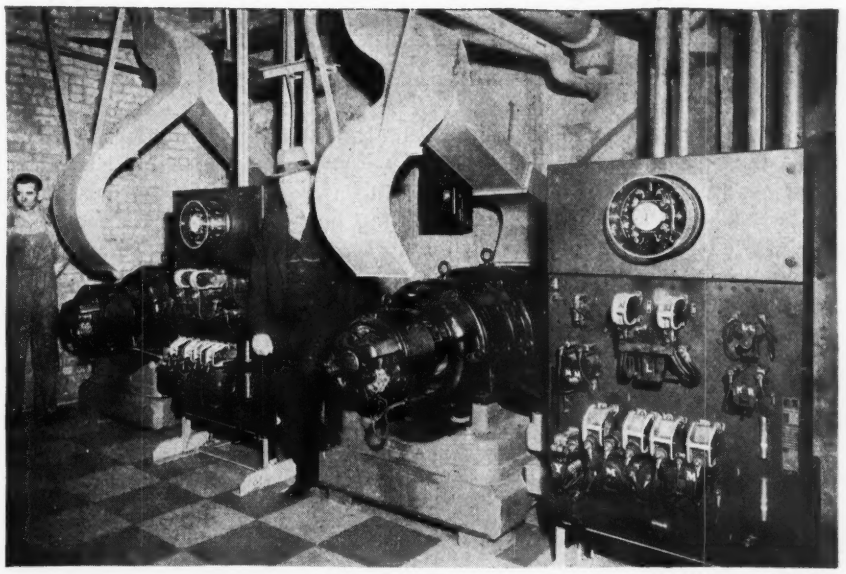
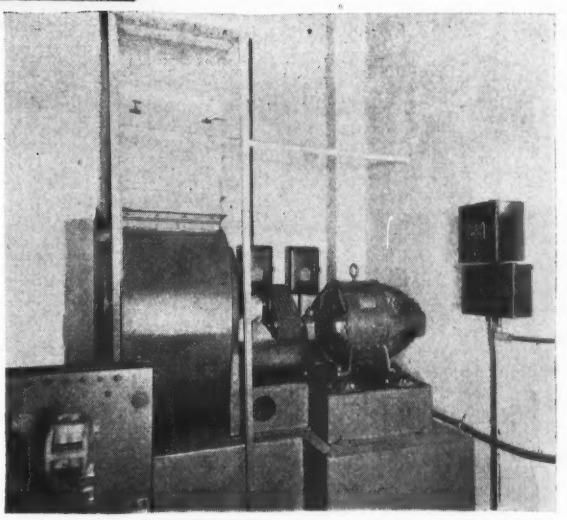


Fig. 2—The motor-generator sets, for the four intermediat-rise cars at 501 Madison Ave., New York City, are in the sub-basement and are cooled by forced-ventilation

Fig. 3—One of the two ventilating fans in the elevator-machine room, Fig. 1. These fans start automatically when the first motor generator starts and they stop when the last motor generator is shut down



interference with operation of automatic devices designed to stop the cars level with the landings. Where such devices are adjusted when cold it has been found that the change in resistance of windings due to heat interferes with the adjustments.

In such a machine room it might be determined that each elevator equipment gives off 800 B.t.u. per minute. Each heat unit is capable of heating 1 cu.ft. of air 55 deg. F., or heating 55 cu.ft. of air 1 deg. In a recently installed system provisions were made to handle 1,500 cu.ft. of air for each elevator. This air change limited the average temperature rise to 29.4 deg. F. above the temperature of the incoming air. The system's design was based on this temperature rise, but it also permitted each piece of apparatus to operate in air of approximately the incoming temperature.

This result was acocmplished by blowing cool incoming air directly against the end windings and rotor or armature of each machine. The duct work was arranged so that each machine received an equal share of cool air, 500 cu.ft. per minute to the motor of the motor-generator set, 500 cu.ft. per minute to the generator and 500 cu.ft. per minute to the elevator-machine motor.

This large volume of fresh air could not be delivered into a closed room without providing to remove an equivalent amount of heated air, which was done by installing a separate exhaust system. This consists of a motor-driven fan, connected by galvanized-iron ducts to exhaust registers located near the ceiling of the room, with a discharge duct from the fan to outside the building. Where the location of the elevator-machine room allows installing a large louvered opening for the escape of heated air directly through the roof or walls, such an arrangement may be satisfactory. If the heated air must pass through ducts of any appreciable length a separate exhaust fan will be found essential.

Blowing cool air directly on the equipment gives an effect substantially the same as if the whole room were at the temperature of the incoming air. If only a general air change is provided the machines will be working in air of practically the high outgoing temperature. The practical value of the former arrangement has been demonstrated by the low temperature at which the elevator equipment operates.

In one case, with direct current to direct-current motor-generator sets it was possible to make duct connections directly to the frames of the motors and generators as in Fig. 7. The air was blown through the windings at a static pressure of about one inch of water. Where alternating current to direct-current motor-generators was used, it was not possible to make pressure-tight connections to the stator or field frames. Instead, the air was blown as a high-velocity jet from a tapered sheet-metal nozzle into the machines, Fig. 2.

Since the atmosphere in metropolitan districts carries a large amount of dust and soot, it is not safe to blow large quantities of unfiltered air through the windings. For that reason it is standard practice to draw the incoming air through an industrial-type automatic self-cleaning oil-saturated filter. To provide for reduced ventilation in cold weather without the complication of alternating-current motor speed control, and to insure against a complete ventilation failure in hot weather, two fresh air fans are installed in each important machine room.

Ease of control is essential to users of elevator equipment; therefore it is considered desirable to make the ventilating system's control automatic. Where motor-generator sets are used it is common practice to provide a switch in each car to start and stop the set serving that elevator. The control of the ventilating system is so arranged that the fans start automatically when the first motor-generator sets starts, and stop when the last motor-generator set is shut down.

This is accomplished by connecting the coil of a small full-voltage starter across two of the incoming leads of each motor-generator set. These starters, one connected to each motor-generator set, then perform the function of relays to control the fan starters. The contacts of these relays are connected in multiple so that when any relay makes contact, the fans will run. The relays are regularly provided with three or four poles, giving enough contacts to control two fresh-air fans and an exhaust fan.

A typical installation of ventilating equipment is shown in Fig. 5, which is a plan of an elevator-machine room for a bank of four intermediate-rise elevators on the 23d floor of a 45-story building. Fresh air is taken in through a window in which both sashes have been replaced by a substantial copper louver. To reach the suction inlets of the fresh air fans the air passes through the automatic self-cleaning oil-coated air filter that removes the dust. The two fresh-air fans discharge into a common duct with a trailing damper fitted and counterbalanced so that it will move easily in response to the blast from either fan. If both fans are running it assumes a mid-position, but if either fan is shut down the damper swings to a position that keeps the air from the operating fan from blowing back through the one at rest. The fresh-air ducts are proportioned for velocities of from 1,000 to 1,500 or 2,000 ft. per minute, depending on their size and proximity to the fan. The

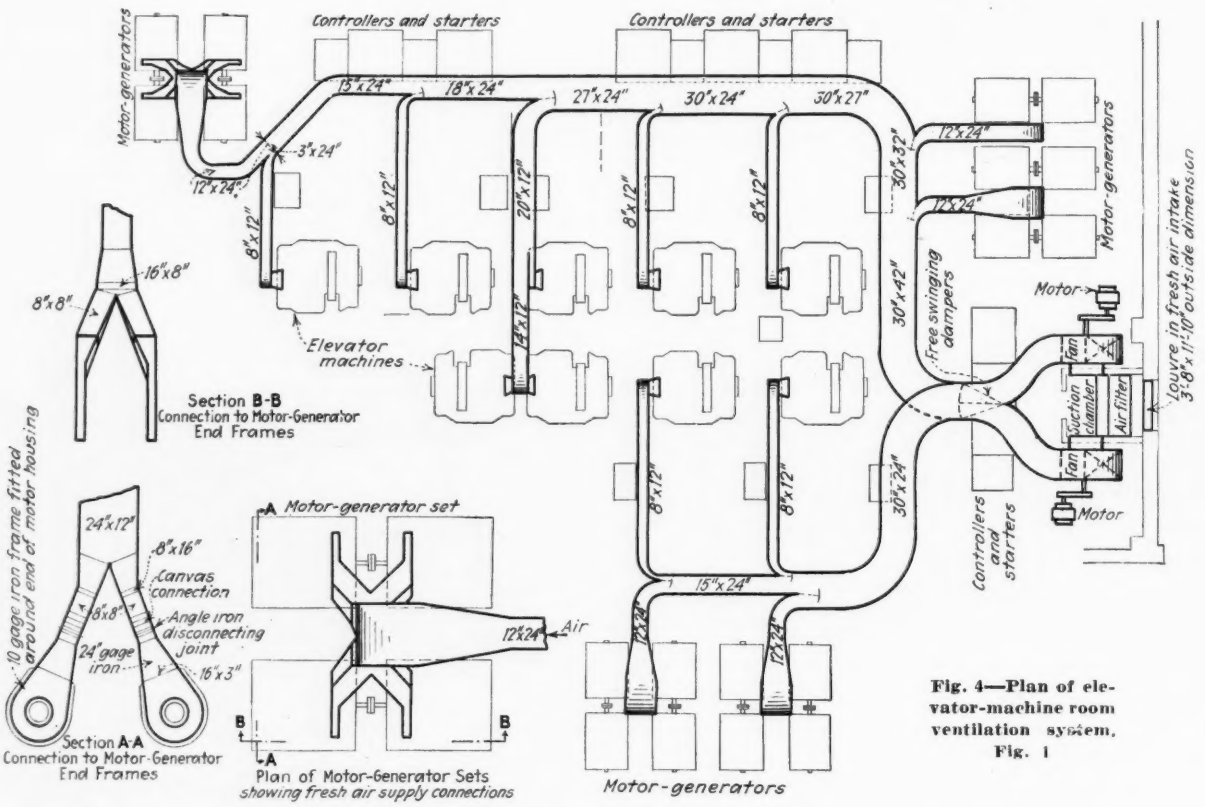


Fig. 4—Plan of elevator-machine room ventilation system, Fig. 1

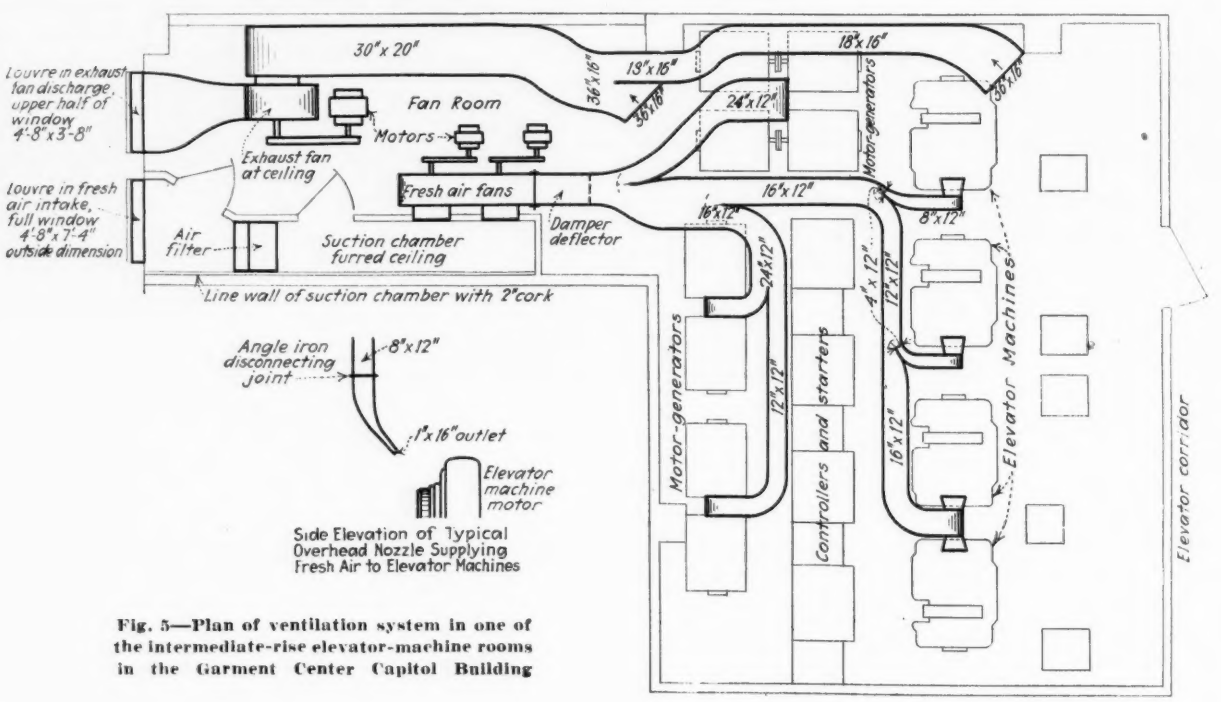


Fig. 5—Plan of ventilation system in one of the intermediate-rise elevator-machine rooms in the Garment Center Capitol Building

friction losses are carefully checked to insure even distribution to each outlet.

The heated air is removed by a motor-driven fan discharging through a duct terminating in a copper louver inserted in place of the upper sash in a window. The fan suction is connected to a duct having exhaust inlets near the ceiling of the machine room, where the air is hottest. The exhaust fan is designed to handle 5 or 10 per cent more air than the combined capacities of the two fresh-air fans, so that a positive pressure will not be built up in the machine room. By maintaining a negative pressure any leakage through partitions or around

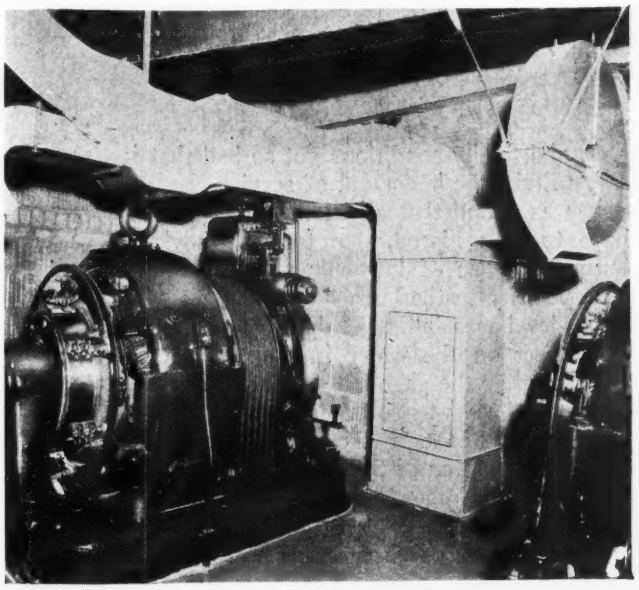


Fig. 6—Ventilation system for two of four intermediate-rise elevator-machines at 501 Madison Ave., New York City. The motor-generator sets for the elevator motors are located in the sub-basement, Fig. 2

doors is inward, thereby preventing the escape of hot air into other parts of the building.

In this installation direct-current to direct-current motor-generator sets are installed. The shape of the field frames is such that, by removing a cast-iron cover designed to protect the end windings, it was possible to bolt the fresh-air ducts directly to the ends of the field frames. A form of construction shown in detail in Fig. 4 was used. In more recent installations with alternating-current to direct-current motor-generator sets the stator and field frames are separated by a cast-iron distance piece having oblong holes cored out at intervals around its circumference, through which air is discharged by the fan action of the rotating parts. With these machines it was not found practical to make a solid duct connection, owing to lack of space. Fresh air was therefore blown directly into the outer end windings of each machine. The air flow through the machines is toward the coupling and is assisted by the fan action of the rotating element. The same arrangement is used in all cases when cooling the large slow-speed direct-current motors of the elevator machines, the fresh-air nozzle being arranged as shown in Figs. 1 and 5.

A large pent-house elevator-machine room containing nine high-rise elevator equipments is shown in Figs. 1 and 4. In this case the proximity of the roof and headroom of 20 ft. permitted easy disposal of the heated air. An extension 7 ft. high was built over a 7x14-ft. opening in the roof. The upper 4 ft. of this extension is composed of louvers on all four sides, giving a louver area of approximately 168 sq.ft. The amount of air handled by the fresh air fans for the nine equipments is 13,500 cu.ft. per minute, giving a maximum velocity through the exhaust louvers of less than 100 ft. per minute.

All ducts are provided with canvas joints where they connect to the fans or elevator equipment, to prevent transmission of noise. Fans and motors are bolted to heavy concrete slabs resting on 2-in. cork blocks. These blocks are, in turn, supported by a concrete base, one inch high, applied directly to the concrete floor of the machine room. This arrangement lessens the possibility of moisture or oil saturating the cork, with resultant loss of resiliency.

Ventilating systems of this design have been in operation with satisfactory results for over a year. The operation of the elevator equipment has been noticeably improved and the useful life of such equipment will undoubtedly be increased. The cost of ventilating equipments described has varied between 4 and 6 per cent of that of the elevators. The annual power consumption for operating the ventilating equipment is approximately 5 per cent of that required for the elevator machines.

There are several factors to compensate for the ventilating equipment cost and power consumption. Where the ventilating air is filtered a machine's windings will remain much cleaner than with natural ventilation. With forced ventilation the temperature of the windings will

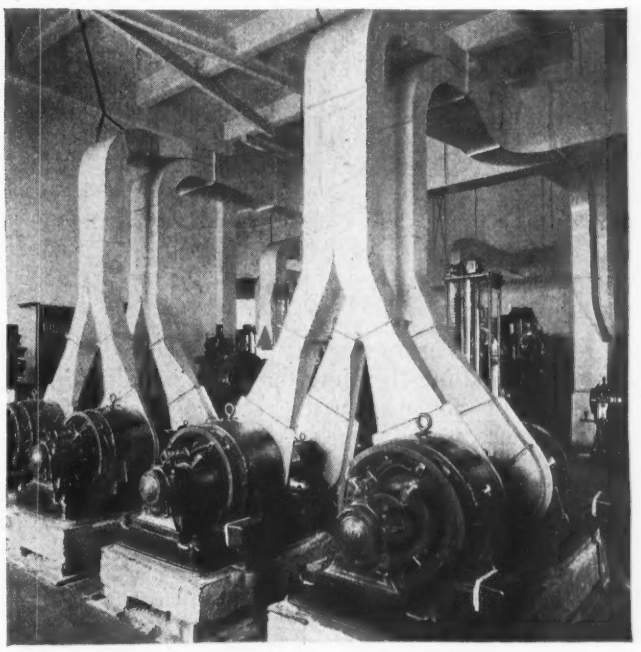


Fig. 7—The ventilating ducts to the elevator motor-generator sets, in the Garment Center Capitol Building, connect directly to the machines

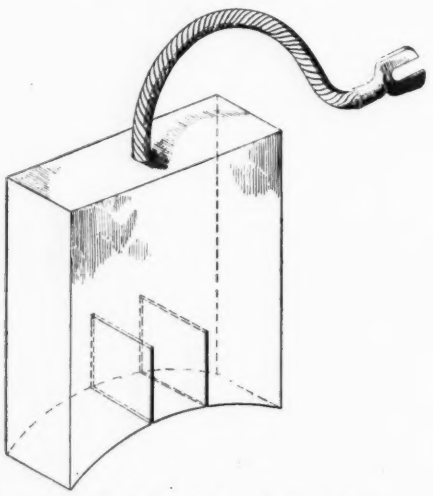
be lower than with natural cooling. These two factors will materially reduce the maintenance costs, and the lower temperature will result in lower copper losses in the machines. When the machines are of the automatic-landing or leveling types the lower temperature of the windings with forced ventilation will insure more accurate functioning of the control equipment. On automatic-leveling machines the amount of leveling of the cars necessary at the floors will be reduced, with a consequent reduction in power consumption and equipment wear and tear.

Acknowledgment is made by the writer to John G. Eadie, Mortimer Freund and Fred A. Einbeck for their assistance in preparing this article.

. . . RIGHT OUT OF THE PLANT . . .

Maintaining Good Brush Contact on Slip Rings

THE ANSWER to the problem on operating brushes on slip rings in the March 17 *Power* brings to mind a trick that I have found helpful in dealing with brush problems. The working face of a slip-ring brush usually has a length of 1 in. or more. By slotting the brush in two places at right angles to the direction



Slots cut in contact surface of brush

of rotation of the slip ring the brush is virtually divided into three, and has therefore three leading edges instead of one. In this manner the scouring action of the brush is increased and helps to maintain good contact with the ring. The slots are made by dividing the contact face of the brush into three equal lengths and cutting the slots $\frac{3}{8}$ in. deep, as in the diagram, with an ordinary hacksaw blade. C. A. H. MACDONALD.

Entre Rio, Argentina

Why the Plant Operating Costs Were High

SOME TIME AGO a change was made from solid to liquid fuel in a boiler plant having two horizontal return-tubular boilers with a total heating surface of 3,500 sq.ft. In connecting the oil burners to the boiler furnaces the engineer could find no convenient place for connecting the steam supply to the burner under the larger boiler. After considering several ways of solving the problem, he hit on the idea of making a connection to the $1\frac{1}{4}$-in. steam line that joined the boiler to the top of the water column.

Things went well for a few days. Then one night during the peak load the top rows of tubes began to leak, and finally conditions got so bad that it was necessary to take the boiler out of service.

It was found that all of the top row of tubes would have to be replaced, due to their having been badly burned because of low water. With steam flowing at high velocity to the burner during the peak load a false water level was indicated due to the lifting, or syphoning, effect on the water in the water column; consequently while the gage glass indicated a safe water level, the actual level was so low as to uncover the upper row of tubes long enough to cause overheating.

An examination of the fuse plug in the rear tube sheet disclosed that a plug too short to project well beyond the inner surface of the tube sheet had been used and that a heavy coating of hard scale prevented the fusible material from melting and giving warning of the low water condition.

In the same plant the exhaust steam from a duplex fuel-oil pump was connected to an inclosed-type feed-water heater after first passing through the heating coils of the fuel-oil heater. After a few months' operation a leak developed in the steam heating coil of the unit, and because the oil pressure inside the tubes of the coil was considerably higher than that of the exhaust steam fuel oil leaked into the steam space, a part of which ultimately reached the feed-water heater and adhered to the tubes, acting as a heat insulator between the water and the exhaust steam. After the leak was discovered and repaired the pump exhaust was turned to the atmosphere direct.

When the change was made to fuel oil, an oil storage tank of about 12,000 gal. capacity was installed. The tank was placed in a shallow pit in the rear of the boiler room and connected to the fuel-oil pump suction. But the tank was not anchored in place. The following summer an unusually heavy rain flooded the low ground and tank pit. The tank was only about one-third full of oil and it floated away from its location, breaking the suction pipe and shutting down the plant, in addition to causing the loss of considerable oil.

In another plant a cross-compound condensing corliss engine operated for several years with 17 to 18 in. of vacuum. As time went on it became difficult to maintain even this low vacuum, and no one seemed to know what to do about it. A change in chief engineers resulted in solving the mystery. When the unit was installed the exhaust pipe had been extended through a trench which was later covered over with concrete to a point beyond the engine and dead-ended with a blank flange on the side outlet of a tee. The blank flange was made

from a piece of thin sheet metal and bolted in place with the usual gasket between the face of the fitting and home-made flange. The other end of the tee was fitted with a companion flange into which a plug had been screwed. In time, the light, home-made flange buckled inward, partly destroying the joint between flange and fitting and allowing air to leak in. As the pipe was well covered, no evidence of the leak could be noted until the floor was dug up.

After replacing the old flange with a proper one, the vacuum gage indicated 24 to 25 in. regularly. It developed that the original reason for the extended exhaust line was to provide for the connecting of a future engine-generator set to the condenser.

It would be interesting to know just how much fuel was wasted in this plant over a period of years with a 150-hp. engine operating at an average vacuum of less than 17 inches.

C. T. BAKER.

Atlanta, Ga.

The Age-Limit Problem

REFERRING to Robert S. Cromley's discussion on the age-limit problem in May 5 *Power*, I think his letter calls for some comment. It seems to be all too true that the solution to the employment problem is a matter of salesmanship. In many cases it seems to be a question of salesmanship versus training and experience or engineering ability, and the salesman usually, perhaps always, wins. This may be quite natural, but it is rather tough on us who have not learned this graceful art of peddling our goods.

I hardly agree with Mr. Cromley when he says that the young engineer may be capable of handling the job more efficiently than the older man; it may be so in a few cases, but in general it is not. The young man may know more of the latest ideas and facts than the old-timer, but the latter, with his experience and knowledge of the fine points, the tricks of the trade, will in the long run be the safer man. Mere knowledge and skill are not enough. In fact, the following amusing experience would seem to indicate that knowledge and skill are not even necessary.

In the spring of 1926 it was my misfortune to work under a man who had, or claimed to have had, years of experience on steam turbines. But he was surprisingly ignorant of what was being done on turbines at that time, and was rather stupid as well. At first I attempted to introduce some ideas that were being used by other manufacturers. But these novelties were all new and strange to him, so he would permit no such heresies in his department. But in spite of his personal shortcomings, his years of experience kept him from doing anything radically wrong. His contacts with engineers and his intimate knowledge of details enabled him to make his machine a best seller in its line. His ideas, or rather his lack of them, acted as a sort of counterbalance to radical ideas that may have been the latest thing with other makers but which did not harmonize with what had already been done on this particular machine and with the policy of the company.

The trouble with young engineers—I am still one of them—is that they are likely to be too sure of themselves. Business men and engineers are a conservative lot, in spite of all their talk of efficiency and progress. The old, experienced man is most reliable in the long run. He acts somewhat like the governor on an engine, he slows things down when they are going too fast, and lets the machine catch up with itself. The old man may not be much for progress, but he is always safe. He is the man called upon in an emergency. This last fact alone ought to justify his being kept on the payroll.

Philadelphia, Pa. ALBERT E. PITCHER.

Inspecting Steel Stacks

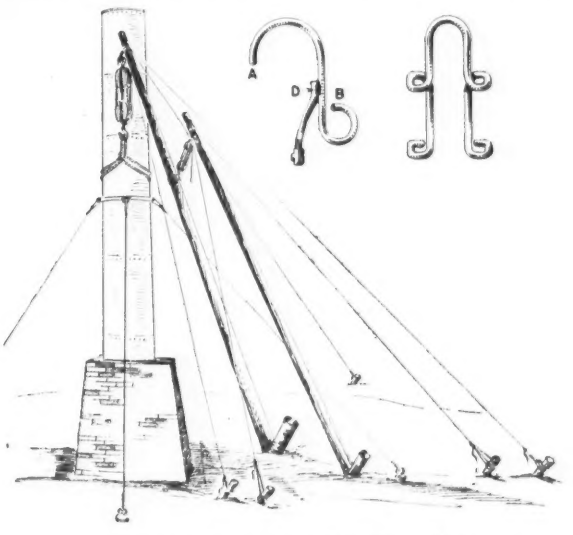
AN EXTERNAL INSPECTION of a steel stack for corrosion, holes in the stack shell or wasted or broken guy strands may be made without ascending the stack. About all the apparatus necessary is a good spy-glass or telescope. The telescope from an engineer's transit or level is ideal.

To make the inspection select four or more points around the stack from which as much of the exterior of the stack as possible may be seen. The points selected should be approximately equidistant from each other, so that, viewing from each point in succession, the entire circumference of the stack may be seen. Good results can be had by holding the telescope in the hands, but a better way is to suspend the telescope from the top of a bar or rod driven in the ground at the various points from which the inspection is to be made. By suspending the telescope in this way the observer can hold the glass at will upon any point and make evenly progressive movements from place to place along the entire height.

It is well to number in rotation the points on the ground from which the several observations are made, and then to record the defects observed in the stack, somewhat as follows: Station 1, elevation about 40 ft.—"Large corroded spot." Station 1, elevation about 60 ft.—"Rusted hole in stack wall." Make similar observations from stations 2, 3, 4, etc. Examine each guy cable in similar manner and record any defects found.

The examination by telescope will enable the engineer to estimate quite closely the condition of the stack. He can judge whether it needs repairs and painting, and decide whether it is safe for a repair man or a painter to climb the stack. In case the stack is too small for a man to ascend inside, or is not considered safe, then rig up a "gin pole" and swing the stack down.

For tall stacks a double gin-pole may be necessary, the shorter pole being used merely for ejecting the heavy pole. Stout trees make an ideal fastening for the guy lines of a gin-pole, and so does a railroad track, but care



Arrangement of gin poles and tackle

should be taken to make the lines fast to the track in such a manner that they do not pass over the top of the rail. This may be done by slipping the rope under the rail, over the top of a cross-tie, then back under the rail again and fastening the rope outside of the rail.

Stacks that are large enough to permit a man to work inside may be scaled for repairs or for painting in the following manner without much danger to the workman, who should determine the safe or dangerous condition of the stack as he works his way upward inside. For scaling a stack from the inside, have a large hook made from ¾- or 1-inch steel, as shown in the illustration. The hook should be made large enough to pass over the top of the stack, the end *A* being outside, while the eye *B* and attached rope tackle hang free inside of the stack. At *D* a piece of ¾- or 1-inch pipe is welded to the shank of the big hook, with a coupling on the lower end. To place the hook in position on the top of the stack, provide enough pipe to reach from the bottom of the stack to its top. Then by hoisting the hook and attaching a length of pipe at a time the hook with tackle attached can be finally put into place. Once this has been done the operator should sit or stand upon a sling made fast to the rope tackle and pull himself upward inside of the stack, inspecting the shell as he ascends.

Before entering the stack the workman should put on a one-piece suit with close-fitting head, wrist and ankle pieces. A small machinist's hammer, flashlight and stack stirrup comprise the necessary tools. The hammer and flashlight should be conveniently suspended from a belt and the stirrup fastened to the seat or chair. As the man draws himself upward he should use the hammer freely to determine, by the sound of the blows, if the stack had become thin or is wasted by oxidation.

Having reached the top, the workman detaches the stirrup and throws one leg over the top of the stack. Then, supporting himself by means of the stirrup, he uncouples the pipe from the hook and transfers it, together with the rope tackle, to the outside of the stack. When that had been done he proceeds with the inspection of the outer surface. At or near the top of the stack, it is necessary to work downward for some distance, then return to the top again and shift the hook around the top of the stack so that other portions of the shell can be reached. This is necessary until a sufficient length of tackle has been run out to permit swinging around the stacks so that every section can be reached without moving the hook.

While working his way down the outside of the stack, the workman should also inspect the fastening of each guy to the stack and arrange for the repair or replacement of any defective parts. JAMES F. HOBART.

Indianapolis, Ind.

Pointers on Attaching Pulley Covering

SIMPLY CEMENTING a leather or canvas covering to a pulley makes a better belt-adhering surface, but there are several other ways to make a much more satisfactory job.

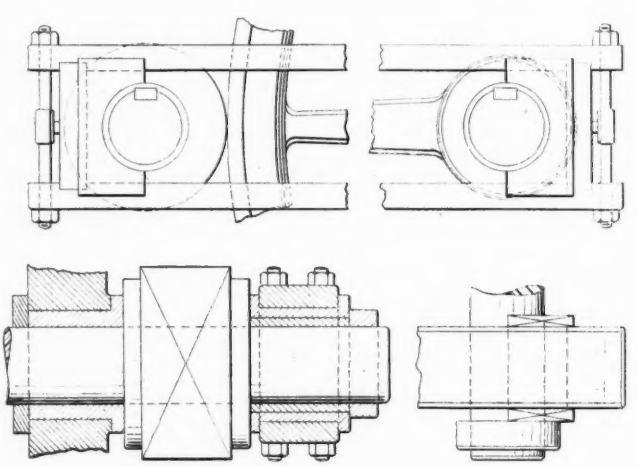
The surface of both the wheel and the belt must be clean, and there is no better way to do this than with an emery wheel. By holding the belt on the emery the inner surface can be well roughened and the ends beveled to a thin edge. If the pulley is to be crowned the edges of the whole covering should be beveled. The roughened surface gives the cement a better hold on the leather and the edges will remain cemented longer if they are made thinner than the stock of the covering. Large wheels, where rivets may be placed through the rim, are more easily kept covered than small ones, where the pulley is of solid construction without web or spokes; so the latter must depend on cement. Where an extra high crown is desired a strip of rubber about one-third the width of the pulley face should be cemented around the center, then another narrower strip cemented on top of this.

A small rope or sash cord offers a good way to press the covering to the pulley and hold it until the cement is well set. With the cover well stretched before attaching, by applying the glue quickly and attaching the whole cover it can be put on with a more even tension than by attempting to stretch it as it is applied. When the covering has been glued and set in place on the pulley the small rope is wound tightly to bring every portion of the covering in close contact with the pulley surface and hold it there until the glue has set. G. G. MCVICKER.

North Bend, Neb.

How Heavy Spur Gear Housing Was Reinforced

THE ILLUSTRATION shows a method of reinforcing a cast-iron housing of a 150-hp. reduction-gear transmission. The reinforcement was introduced subsequent to a fracture of the housing casting between the shafts of the heavy gears. The method adopted proved so successful that all the heavy gear housings of a factory were treated likewise.



Gear housing reinforced on outside by steel bars and half bearings

The shafts were extended to give a bearing surface on each side of the gears. Then two steel bars were used to support a half bearing shell on the outer side of each shaft as shown. This relieved the gear housing of all undue strain and reduced materially the maintenance of these particular transmissions.

London, England. J. T. TOWLSON.

From Among Readers' Problems

Conducted by
L. H. MORRISON

LOSS TO ASHPIT—*With coal containing 10 per cent ash and costing $5 a ton, there is 25 per cent combustible in the ash. What part of the $5 goes to the ashpit?* E.C.S.

In order to solve this with the conditions given, it must be assumed that all the ash finds its way into the ashpit, which in most cases is not strictly true, as some ash finds its way up the stack. It is also assumed that the 10 per cent ash refers to the chemical analysis. Each ton (2,000 lb.) of coal as purchased would contain 1,800 lb. combustible and 200 lb. ash. Considering that it is only combustible for which you are paying money, each pound would cost $\frac{\$5}{1{,}800} = 0.00277$, or 0.277c. The refuse in the ashpit would be $\frac{200}{0.75} = 266$, representing 200 lb. of ash and 66 lb. combustile. Since each pound of combustible costs 0.00277c., 66 lb. would cost 18c. That is, for each $5 paid for coal, 18c. is wasted in combustible in the ashpit.

Another way of looking at the problem is that in buying the coal originally you are paying as much for the ash as for the combustible and each pound of coal as purchased costs $\frac{\$5}{2{,}000} = 0.0025$ or ¼c. Hence the 266 lb. of refuse in the ashpit would cost you $266 \times 0.0025 = 66\frac{1}{2}$ cents. Which solution one accepts depends upon the interpretation of the question.

LOAD ON TRANSFORMERS—*I have three 100-kva. transformers connected delta on the primary and on the secondary to step down from 4,600 to 2,300 volts. These transformers supply power to four synchronous motors with a total capacity of 500 hp. Are these transformers large enough for this load? What is the rated ampere output of the three transformers when connected in delta?* O.E.G.

The load on the transformers will depend upon the load on the motors and the number in operation at any one time. The load on the transformers in kilovolt-amperes with full-load on the motors is $Kva. = \frac{H_p \times 746}{E \times 1{,}000}$, where H_p is the total horsepower rating of the motors and E is their efficiency. Assuming that the motors are all the same size and have an efficiency of 91 per cent, then the kilovolt-ampere input is $Kva. = \frac{500 \times 746}{0.91 \times 1{,}000} = 410$. This is based on the assumption that the motors are rated at unity power factor. If the motors are rated 500 hp. at 0.80 power factor their full-load input will be $410 \div 0.80 = 512.5$ kva.

The transformers are good for only 300-kva. load at their normal rating. If the motors were all operating at their full load the transformers would be overloaded by $410 - 300 = 110$ kva., or $512.5 - 300 = 212.5$ kva., depending on the power-factor rating of the motors. These calculations do not mean very much as to the actual load on the transformers, since the motors may be operated and loaded in such a way that their input is within the rating of the transformers. The only satisfactory way of determining the load on the transformers is to connect a wattmeter or an ammeter in the circuit and determine their output. A graphic wattmeter is preferred for this work, as it gives a record of the load over any given time.

The current output of the three transformers at their normal rating when supplying a balanced load is $I = \frac{Kva. \times 1{,}000}{E \times 1732}$ where I and E equal the current and volts, respectively. In this case the full-load current of the transformers is $I = \frac{300 \times 1{,}000}{2{,}300 \times 1.732} = 75.3$ amperes.

AMOUNT OF GAS DISCHARGED FROM CHIMNEY—*If a ton of carbon is burned in a furnace using 20 lb. of air per pound of fuel, how many pounds of carbon dioxide, free oxygen and nitrogen will be discharged up the chimney?* C.L.A.

To burn a pound of carbon to CO_2 requires 2.66 lb. of oxygen. Hence in burning 1 lb. of carbon to CO_2 we send up the chimney 1 lb. of carbon + 2.66 lb. oxygen = 3.66 lb. of CO_2, and for 2,000 lb. of carbon there would be $2{,}000 \times 3.66 = 7{,}320$ lb. of CO_2 discharged up the chimney.

Air contains 0.23 parts by weight of oxygen, and 20 lb. of air would contain $20 \times 0.23 = 4.6$ lb., so the total oxygen supplied to burn 2,000 lb. of carbon would be $2{,}000 \times 4.6 = 9{,}200$ lb. of oxygen. But as combustion of the carbon requires only $2{,}000 \times 2.66 = 5{,}320$ lb. of oxygen, there would be $9{,}200 - 5{,}320 = 3{,}880$ lb. of free oxygen discharged up the chimney.

As air contains 0.77 parts nitrogen by weight, there would be $2{,}000 \times 20 \times 0.77 = 30{,}800$ lb. of nitrogen received and discharged up the chimney.

RESISTANCE OF ELBOWS AND GLOBE VALVES TO FLOW OF STEAM—*In computing the flow of steam through pipe lines, how is allowance made for the retarding effect of elbows and globe valves?* B.A.H.

It is customary to allow for the resistance offered by fittings by assuming an added length of straight pipe that would have an equivalent resistance. There is considerable variation in the form and roughness of commercial fittings of the same nominal pipe sizes and for the flow through fittings. General rules cannot be established that are as closely in accord as the accepted formulas for flow through straight pipes.

However, for practical purposes, where L is the equivalent length of pipe in feet and d the diameter in inches, the length of pipe equal to the resistance of one standard 90-deg. elbow may be taken as found by the formula $L = 6.3\ d \div \left(1 + \frac{3.6}{d}\right)$ and for a globe valve $L = 9.5\ d \div \left(1 + \frac{3.6}{d}\right)$

PROTECTING INDUCTION MOTORS AGAINST REVERSE PHASE AND PHASE FAILURE—*What is the best way to protect induction motors against phase failure and phase reversal? Will a voltage relay, connected to the motor terminal so that its contacts are held closed when the motor is energized, protect against single-phase operation?* M.E.W.

A polyphase motor operating single-phase acts as a phase converter and maintains a polyphase voltage at its terminals as long as it is supplied with single-phase power. This characteristic makes it impossible to use ordinary voltage relays to protect polyphase motors against single-phase operation. A failure of one line does not remove the phase voltage on the motor side of the fault.

Thermal relays are coming into use that are operated directly from the temperature of the motor's stator core or its windings. These offer one of the best means of protecting polyphase motors against single-phase operation. As long as the motor does not overheat, such as would be the case if it were lightly loaded, there is no objection to its operating single-phase. When the temperature exceeds a safe limit the thermal relay on the motor will function and disconnect the machine from the line. Unless they are set near the full load current rating of the motor,

the ordinary thermal-type relay on motor starters will not protect the motor against single-phase operation.

There are two methods in general use for protection against phase reversal and single-phasing. The reverse-phase relay is simply a miniature polyphase motor with a very light, rotating-disk armature. So long as the phases are in correct relation the armature tends to rotate against a contact which closes one of the main control circuits. If one phase of the power circuit is reversed the relay's armature tends to rotate in the opposite direction and opens the main control circuit. In the case of single-phasing, if the motor is running it will generate a polyphase current which will keep the reverse-phase relay closed, but when the motor stops the reverse-phase relay will remain open, because a single-phase current will not close it.

The other method is to close the main contactors by small 3-phase motors. These motors will act in much the same manner as the relay just described; tending to open the switch on reversal of phases and failing to close on single-phasing.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

WHAT is the most direct way by which electricity can be obtained from the sun's radiant heat? What methods have been suggested but not carried out? P.M.

NO PRACTICAL METHOD has yet been developed for obtaining any large amounts of electrical energy directly from the sun. Indirectly, however, the sun is the source of all the electrical energy that is generated in the power plants of today. Coal, natural gas, oil and wood fuels are all vast sources of stored energy derived from the sun and which the power plant transforms into electricity. Water power also may be traced back to the sun, since it is the sun's energy that elevates the water from the ocean and so gives it the potential energy utilized by the hydro plant.

A number of sun plants have been built and operated with some success that collect the sun's rays on various arrangements of mirrors which direct the heat on water to produce steam. The steam is used in an engine to generate electrical energy.

The earth receives energy from the sun at a rate equivalent to about 1.37 kw. per 10 sq.ft. of surface, which, of course, is available only on clear days. Sun plants have been built that have converted 57 per cent of the sun's energy into steam. At Cairo a plant occupying less than an acre of space develops 50 b.hp. throughout a 10-hr. day. The area of sunlight intercepted is only 13,269 sq.ft., or less than one third of an acre; but it is necessary to place the heat-absorber units sufficiently far apart so that they will not shade each other in the forenoon and late afternoon.

B. F. SHURMAN.

New Orleans, La.

SCIENTISTS HAVE LONG SOUGHT a practical method whereby sunlight might be directly converted into electrical energy. Although methods for accomplishing this result have been known for a number of years, none has yet proved practical for the generation of large amounts of power for industrial use.

Until recently the most successful sunlight cell consisted of a copper-oxide sandwich, one of which, only 3 in. square, has been driving a small electric motor in a Berlin laboratory for several months. A sunlight cell that greatly increases the production of electrical energy has recently been announced by Dr. Bruno Lange of the Kaiser Wilhelm Institute of Berlin.

Dr. Lange's sunlight cell consists of a sheet of metal covered with a thin layer of silver selenide, which, in turn, is coated with a transparent layer of a special metal only a few molecules thick. Light passing through the transparent film sets up a current between the two layers of the metallic sandwich.

For a given strength of sunlight this silver selenide cell produces electric current 50 to 150 times greater than the copper oxide cell. It is claimed that 1 square mile of silver selenide cells will produce approximately 300,000 kw. The cell, it is claimed, does not lose its efficiency with age, but, of course, its usefulness is confined to daylight hours only. C. J. BOWERS.

Atlantic City, N. J.

THE QUESTION BY P.M. on obtaining electricity direct from the sun is one that has attracted considerable attention—much of it misguided because of the lack of fundamental knowledge by those doing the work. Utilizing the heat of the sun on the earth is very much like attempting to use the power of the wind, the waves or the tide. It is all low-head energy, and the volumes that must be handled, the areas involved and other considerations make the cost so high as to be uneconomical except in special cases for small powers. Several schemes are in use where the heat of the sun produces steam for power purposes, but these are small-capacity installations.

Attempts have been made to use the thermocouple principle to generate electricity directly from the sun. About twenty years ago a company was organized in New York City to promote such a scheme, but after one or two years of promoting it closed up shop. Anyone familiar with the limitations of the thermocouple would not seriously attempt using it to convert the heat of the sun into electric power. Until the thermocouple can be successfully used for this purpose in a furnace, where all the elements involved can be controlled, there is little use thinking about it as a means of converting the sun's rays into power.

It has been estimated that on a bright day the sun's energy delivered on 1 sq.ft. is 0.137 kw. When the efficiency of any commercial means of converting this into a usable form is considered, this figure becomes about 0.01 kw. per sq.ft. or 1 kw. per 100 sq.ft. of area. Add to this the large percentage of time that the sun does not shine, either because of clouds or at night, the kilowatts in the sun's ray become pretty elusive articles. A. F. BLACK.

Chicago, Ill.

A Question for Our Readers

THE BOILERS in our plant operate at an average pressure of 430 lb., and the feed line pressure runs around 500 lb. When coming up with load in the morning the automatic feed-water valves tend to close off suddenly owing to the rising water level in the boiler. When these valves close, the feed line pressure between them and the check valve at feed pump rises to 700 to 750 lb. pressure. I should like to know the cause for this high pressure and what can be done to obviate it. H.R.L.

Suitable answers from readers will be paid for[1] and published in the Aug. 4 number

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)
Morrison's *American Diesel Engines;* Walker and Crocker's *Piping Handbook;* Norris and Therkeisen's *Heat Power;* Emswiler's *Thermodynamics;* Church's *Steam Turbines;* Uehlings' *Heat Loss Analysis;* Croft's *Steam Power Plant Auxiliaries and Accessories;* Powell's *Boiler Feed Water Purification;* Osborne's *Power Plant Lubrication;* Moyer and Fritz' *Refrigeration;* Rietschel - Brabee's *Heating and Ventilation;* Annett's *Electric Elevators.*

Re-exciting Loaded Alternators In Parallel With Others*

By D. D. HIGGINS and E. WILD
Commonwealth Edison Company
Chicago, Ill.

ONE OF the early questions which arose in the parallel operation of alternating-current generators was, what will happen if the field circuit is opened while a generator is carrying load and in parallel with other generators? This proposition is somewhat academic and no doubt has been solved to the complete satisfaction of students and others using laboratory set-ups or small generators whose behavior, in so far as customers' service is concerned, is of no serious consequence.

Operators of large power stations and interconnected systems have disposed of the question in various ways as evidenced by replies to a questionnaire. It was found that there was a lack of conclusive data bearing on the behavior of turbine-alternators when operated with an open field and, in general, it was the impression that something very serious might result if the field was re-established before disconnecting the generator from the bus. The usual practice therefore was to take the unit off the system, re-excite it and resynchronize.

Experiences Obtained

While the foregoing was the general feeling, there was no evidence to support it; in fact, the evidence produced was negative. As the size of individual units increased, and large, single machines constituted a considerable percentage of a station's capacity, and an interruption on one of them seriously affected the stability and uniform operation of the system, this old question came to the front for serious consideration.

In order to establish a reasonably safe operating procedure for such emergencies and one that will re-establish normal conditions just as soon as possible, the authors have collected data on experiences and statements from various sources and have determined, by tests, the behavior of large units under this abnormal condition.

Replies from ten operating companies and one manufacturer brought information about sixteen cases in which field switches were reclosed without cutting the generator off the bus. No one reported any disturbance on the reclosing of the field. The authors have rather complete information on eighteen other cases wherein the field circuits were reclosed without any difficulty.

Seven operating companies stated they had promptly reclosed the field switch, or would not object to its being done.

Three stated they would not reclose the switch, but would cut the generator off the bus.

One manufacturer of large units recommended the field switch be reclosed.

These statements concerned machines of from 8,000 kw. to 65,000 kw., both steam and hydro.

It is the practice in unattended hydro-electric plants to have the generators thrown on to the bus unexcited when about up to synchronous speed, after which the field is applied and the unit pulls into step.

Replies From Operating Companies

The replies from operating companies probably represent the accumulated experience over a great many years and while probably not complete, no single case is cited wherein trouble resulted from reclosing the field circuit. It seems reasonable to conclude that where the general feeling is in opposition to such a practice, had there been anything to support such a stand reference to it would have been made.

It would seem from some of the replies to the questionnaire that the behavior of unexcited generators is not very well understood, because several references are made to the anticipated danger of pole slippage, out-of-step and out-of-phase conditions. In practically all cases of record referred to in answering the questionnaire, and in eighteen cases of which the authors have first-hand information, the generators continued to carry load; sometimes they did not drop any, sometimes as much as 30 per cent, but in all cases they carried some. This indicates that the generators did not drop below synchronous speed, but probably went above speed, and that pole slippage is of no moment. In the tests on the 60,000-kw. generator there is positive evidence that the rotors drifted ahead of synchronous speed, and by different amounts. This was probably true in the other cases. It is therefore reasonable to believe that pole slippage as associated with possible complications incident to the opening of the field circuit is not harmful.

With the re-establishment of excitation the rotor poles build up slowly, and, as they do, the speed of the rotor changes slowly and the rotor and stator poles lock into step with properly related polarities.

The question of subnormal excitation of a generator has a bearing on this subject because of experience which indicates what the effect on a generator is when it slips a pole due to reversal of exciter polarity resulting from weak exciter field, etc. The point that should be borne in mind is that the exciter should never be operated below the knee of its saturation curve. If it is it may be overpowered by the induced voltage in the rotor circuit when the field switch is reclosed, causing the rotor poles to reverse as fast as they try to lock in with the stator poles. The harmful effect of such an occurrence on a large system is moderate as measured by bus-voltage disturbance, and apparently negligible in so far as harming the generator. Aside from the remote possibility of accumulated dust and dirt being ignited by sparks from poor electrical joints in the steel structure of the rotor, no damage should be anticipated. No doubt, currents of high magnitude exist in the steel of the rotor at the time when the rotor speed differs from that of the armature poles.

Cases of this kind of disturbance and on units of 35,000 kw. have resulted in a 10 to 12 per cent dip in bus voltage, and, aside from a groan of the unit, did not interfere with parellel operation in the system.

As subnormal excitation may allow pole slipping, this point was taken into consideration in the tests described below, and normal setting of all rheostats was maintained.

Tests Made on Two Units

Tests were made on the restoration of the excitation of alternators of 30,000-kw., and 60,000-kw. capacity. The first unit was rated 35,000 kva., 85 per cent power factor, 12,000 volts, 1,200 r.p.m., 60 cycles, driven by a tandem-compound turbine. The field switch was opened on this unit when supplying a 15,000-kw. 72-per cent power factor load. The field switch was left open for approximately 1½ min. There was no violent fluctuation of current or voltage while the switch was open.

A second test with the same set-up of values resulted in the same conditions. This was followed with a test when the unit was loaded to 21,000 kw. Results were about the same, except that the bus voltage dipped to 11,000.

The 60,000-kw. unit on which tests were made comprised a 17,000-kw., 1,800-r.p.m. generator driven by a high-pressure turbine and a 43,000-kw. 1,200-r.p.m. generator driven by a low-pressure turbine with a reheat boiler between the high- and low-pressure turbines. During two preliminary tests the unit was given a load of 20,000 kw. at 85 per cent power factor. The switch was opened, which cut off the excitation of both fields. The switch was left open for approximately three minutes, during which time the hand of the synchroscope made 16 revolutions, showing that the field of at least the high-pressure generator was slipping ahead of the system slowly. The

*Abstract from a paper "Re-establishing Excitation of a Loaded Alternator in Parallel With Others," presented at the American Institute of Electrical Engineer's summer convention, Asheville, N. C., June 22 to 26, 1931.

speed of the high-pressure unit was compared with the system by means of the synchroscope, which was connected between the house alternator on the high-pressure unit's shaft and the 2,300-volt bus, which was alive from the main 12,000-volt bus.

Reclosing of the field switch occurred about the time the synchroscope showed the high-pressure rotor to be 180 deg. out of phase. That is, the mechanical time-phase relation of the poles of the rotor was 180 deg. away from the normal position. There was a total absence of surging or violent fluctuations; the excess current on both generators simply subsided, the synchroscope needle stopped at the in-phase position and the voltage came to normal.

A second set of tests was run on the 60,000-kw. unit, during which oscillograph records were made. The field switch was opened three times in all. On the first test the machine had 30,000-kw. load at unity power factor. On the second test the machine had the same load, 30,000 kw., at unity power factor, but the field switch was kept open over 30 sec. On the third test the machine had 50,000 kw. at 80 per cent power factor when the switch was opened. The general performance of the machine in each test was similar, but the amplitude of the current and voltage oscillations was much greater for the higher load.

The conclusions are drawn that it is recognized that different types of generators behave in different ways when the excitation is cut off. Old units having low-resistance field windings and operating with 125-volt excitation are more erratic than later machines employing 250-volt excitation, probably due to lower energy loss in the rotor. If the unit is carrying less than three-quarter load there is no danger in reclosing the field switch. If the unit is carrying more than three-quarter load it will be prudent to lower on the governor before reclosing the field switch.

If the bus voltage has dropped to 60 per cent of normal it will be prudent to open the generator switch to prevent other generators dropping out of step.

Owing to its reactance, it is impossible for the rotor field to snap up to full strength; and, correspondingly, owing to a weaker magnetic coupling, it is impossible for the rotor to change speed instantly; therefore, there can be no shock such as paralleling a machine out of phase.

▼ ▼ ▼

Burners Handle Oil, Gas and Pulverized Coal Simultaneously

MANY INDUSTRIAL plants find it desirable to burn two or more fuels simultaneously. This condition is frequently found in oil refineries where various waste fuels are available. The burners here shown for handling oil, gas and pulverized coal simultaneously were described by R. C. Vroom of the Peabody Engineering Corp. at a recent meeting of the Metropolitan Section of the A.S.M.E.

Fig. 2 shows a convenient and reliable form of high-capacity combined burner for oil, gas and pulverized fuel. It is a true combined burner in that all three fuels may be burned simultaneously if desired. It is not necessary to remove a part of the burner for firing one fuel in order to insert a part of the burner for firing another fuel. The combustion air for the fuel being fired sweeps over and cools those parts of the burner for firing the other two fuels. A change-over can be made almost instantaneously.

The gaseous fuel is admitted to the furnace throat in an annular stream issuing from the inner periphery of the ring-shaped gas chamber just inside the furnace throat opening. The gas impinges on the rapidly rotating column of air from the curved blades of the air register.

Pulverized fuel and carrier air are admitted tangentially to the inner periphery of the rifled coal burner body coaxial with and adjacent to the gas chamber. This stream is picked up and mixed with the secondary air from the register rotating in the same direction.

The liquid fuel issues from the wide-range mechanical atomizer tip in a diverging conical sheet which just clears the furnace throat surface. All the rotating combustion air from the register must pass through this sheet.

Fig. 1 shows a similar combined burner for lower capacities. In this burner the coal is admitted tangentially into a ring-like volute-shaped coal chamber and delivered to the furnace throat through an annular slot in the inner periphery of the chamber. The gas chamber is between the coal chamber and the furnace front plate.

In the commercial application of these combined burners for firing waste fuels numerous combinations of gaseous, pulverized and liquid fuels of various types are encountered.

In addition to natural gas, many kinds of industrial gases are being fired by such units, among them being refinery still gases. Such gaseous fuels sometimes have a heat content per cubic foot as high as 2,200 B.t.u.

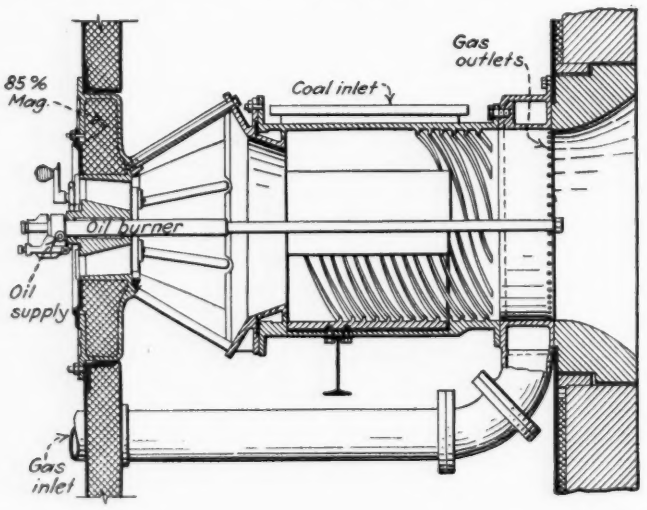


Fig. 1—Combined coal, gas and oil burner

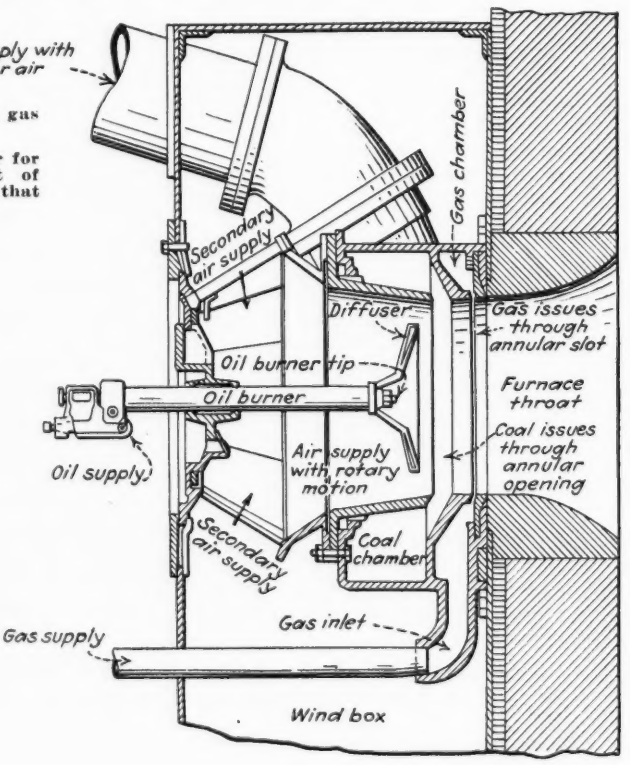


Fig. 2—Combined burner for coal, gas and oil, but of higher capacity than that shown in Fig. 1

The Repair of Refrigerating Plant Machinery

By M. E. BELL
Chief Engineer
Golden State Milk Products Company

THE ANNUAL overhaul period of a refrigerating plant is usually during the winter or dull season, but a good engineer or repair man will know what equipment should be overhauled and what repairs are necessary if he has kept a proper record of the performance

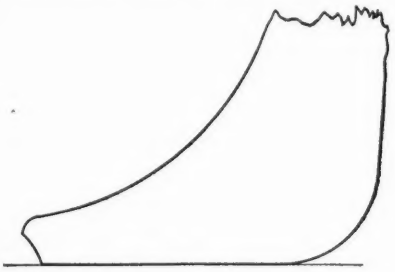


Fig. 1—Indicator diagrams should be taken periodically

and repairs on the equipment during the year. Indicator diagrams should be taken periodically under the most severe operating conditions, as well as under normal operation, so that the record of cylinder performance may be referred to when the overhaul period comes around. Inspection and repairs should be made in the following sequence: (1) the bed bolts and foundation, bearings, journals, pins, crosshead guides, etc.; (2) the cylinder, piston, piston rod, packing, head clearance, head gaskets, etc.; (3) the machine valves; and (4) the suction, discharge, bypass, and interconnection stop valves.

As the majority of present-day machines are of the high-speed type, this type only will be considered, though the repairs on any machine are essentially the same.

The first operation on the annual overhaul is determining if the frame is level and if all holding down bolts are tight. If the foundation is oil-soaked the bad part should be chipped away and new grouting run in. The crankshaft should be checked for level, as well as for right angles with the cylinder bore.

After the shaft has been leveled and placed at right angles to the cylinder bore, the bearings must be shimmed and scraped to fit the journals in this position. The main bearing is the most subject to wear and is the most difficult to fit. This bearing is usually made in four pieces, of cast-iron with babbitt lining.

The rotation of the shaft, and therefore the oil grooving in the bearings, has a great deal to do with satisfactory lubrication and bearing life. The oil grooves should be made in the bearings in accordance with the direction of rotation of the shaft. The sketch, Fig. 2, shows effective grooving for bearings when the rotation is "under." It is important to ease off the edge of the bearing on the side against rotation so that the bearing will not scrape the oil from the journal and prevent it from entering the grooves.

In setting up bearings after they have been fitted care must be taken not to get them too tight. On a journal of about 10 in. in diameter about 0.006 in. should be allowed to start, the wedge being pulled up straight when taking up on it. The final adjustments should be made after the machine has been run several days.

Crankpin brasses on a pin about 6 in. diameter will run satisfactorily with 0.002 to 0.003 in. clearance if they are in good condition and properly lined up. The end clearance on the crankpin should be about the same, 0.002 to 0.003 inches.

Crosshead-pin brasses are the hardest to get at and must be adjusted according to the resistance, or "drag," of the connecting rod on the pin when it is being slid across the pin. The crosshead brasses should have plenty of side clearance, about $\frac{1}{8}$ in. on a 4-in. pin.

Crosshead guides should be checked with inside micrometers to determine the amount of wear. If the guides are not worn too much, they can be trued up by scraping with a bearing scraper

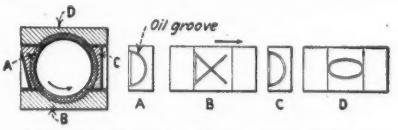


Fig. 2—Oil grooves on four parts of main bearing

and finished with an oil stone. When the guides and crosshead shoes are parallel and in good condition the tolerance can be as little as 0.003 in.

The indicator is a great help in determining the condition of the cylinder, and should reveal the defects to be looked for. Check the cylinder diameter with an inside micrometer through its full length both horizontally and vertically to see how much out of round it is. If there are shoulders at the end of the stroke, they may be cleaned up with a bearing scraper and finished with an oil stone.

A cylinder should be rebored and a new piston installed when the estimated loss in capacity, and therefore loss in value of the machine, for one year will equal the cost of the job. If worn out of round or tapering more than 0.001 in. to inch of stroke it is impossible for the rings to seal properly. With cast-iron pistons the rule of 0.001-in. tolerance to inch of bore is satisfactory. If the piston is equipped with bull rings or wearing rings of anti-friction metal the tolerance can be reduced to two-thirds of that of the cast iron.

The end opening in the rings can be as little as 0.002 in. in a 10-to-15-in. diameter ring if they are rough-turned, but with twice that much if the rings are ground. The side clearance should be as little as possible to permit free movement of the rings in the grooves.

The end clearance in the cylinder should depend upon the kind of load. If it is on low-pressure work and saturated suction the clearance should be as little as possible, because of re-expansion of gas and loss of capacity. If the bearings are kept keyed up the clearance can be about 0.150 in. total for both ends of a machine of 10-to-15-in. bore. The head-end clearance on high-speed short-coupled machines of this type should be about 0.012 in. more than the crank end, to compensate for the expansion of the rods when they warm

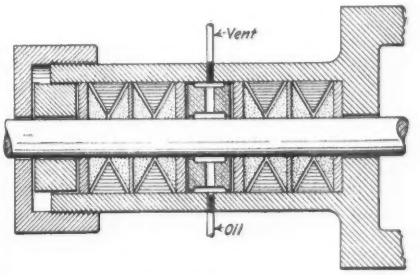


Fig. 3—Stuffing box packed with metallic packing and fitted with an oil seal

up. This would permit about 0.069 in. on the crank end and 0.081 in. on the head end.

The oiling system should be thoroughly cleaned every 3,000 to 3,500 hr. operating time. If the system is of the continuous filter type new filter cloth should be installed. New good grade ice-machine oil should be added, because some of the oil will work into the cylinder on the rod and then into the system. If any other than ice-machine oil is used trouble will develop in freezing up expansion valves and evaporating coils.

This type of compressor — in my opinion, any type—should have the rod packed with metallic packing only, as it tends to reduce the wear on the rod and danger of scoring to a minimum. Fig. 3 shows a successful packing designed and made in our own plant. It is very important to lubricate metallic packing properly. The oil serves as a gas seal as well as a lubricant.

The valves should all be removed and thoroughly cleaned every 3,000 to 3,500 hr. of operation. The stems on ammonia stop valves should be packed with metallic or semi-metallic packing and kept well lubricated.

Packing is the contributing cause of about 90 per cent of all centrifugal pump trouble. All pumps in a refrigerating plant should be packed with metallic or semi-metallic packing. If the shafts are in good condition and are correctly packed they should operate for several years with a minimum of trouble.

*Abstract of paper read before California Chapter, National Association Practical Refrigerating Engineers.

Economic Fundamentals Of Steam Heating Plants

FUNDAMENTAL distinctions between central heating plants and central station boiler plants were made clear by Melvin D. Engle, station engineering department, the Edison Electric Illuminating Company, of Boston, in a paper presented before the National District Heating Association, June 2 to 5, 1931. Mr. Engle's views, as expressed in this paper, may be summed up as follows:

A mistaken notion still persists that the economics of the central steam heating utilities are the same as those of the electric utilities. Careful study of the problem will show that the whole economic structure differs in the two cases.

Load Factor Half That of Electric Station

The load factor of the electrical load is somewhere between 40 and 50 per cent, and is constantly increasing, while that of the steam heating load rarely exceeds 30 per cent. Naturally, then, the money that can be invested for high efficiencies is much smaller in the central heating plant.

Steam distribution losses are practically constant, whereas electrical distribution losses vary with the load. The annual peak load of the steam plant may last several days, whereas that of the electrical load lasts a few hours.

Interconnection of heating plants is generally impracticable. The minimum load of the steam heating utility is relatively much lower. It generally pays, because of the high cost of transmission, to locate a steam heating boiler plant close to the center of load, even if land is expensive. The cost of an elaborate and highly ornamented building is rarely warranted.

It is seldom economical to return the condensate. Therefore, enormous quantities of make-up water are required, and this must usually be taken from the city water supply main. Since it is generally impracticable to supply appreciable water storage on the site, several water connections should be made to insure supply.

Because of high land values at the plant, it is generally best to provide any coal storage beyond 24 hr. at some outlying point.

Where the coal is unloaded at some other place than the boiler plant, it is logical that it should be crushed and foreign material removed before it is sent to the steam heating boiler plant. Crushing to a small size at the unloading plant will result in a material saving.

A steam pressure of about 200 lb. gage seems to be the economic maximum for the distribution lines leaving the boiler plant.

Because of the low load factor of the steam heating load, turbines and generators extracting electrical energy from all the steam generated in the boiler plant are seldom justified.

The air heater seems to be especially well adapted to use in the steam heating boiler plant. It permits a designer to design the steam-generating unit to operate at higher capacity without exceeding the flue gas temperature that can be handled by indirect draft fans. The air heater also increases the capacity of pulverizing equipment when handling wet coal. Economizers are usually hard to justify for steam heating boiler plants, because of their high first cost.

The principal requisite of the fuel-burning equipment is high capacity per square foot of ground area. The equipment should also be of such a design that maintenance work can be done quickly and while the boiler is on the line carrying load at reduced capacity.

In spite of their high first cost, water-cooled furnace walls are usually justified for those wall areas subjected to the most severe punishment.

Because of their low cost per unit of space and capacity, extreme care should be exercised that the forced- and induced-draft equipment does not limit the capacity of the steam-generating unit. Other requirements are ruggedness, reliability and flexibility.

Steam heating boiler plants are normally near centers of dense habitation. Hence the problem of air pollution by smoke, cinders and fly ash is important.

The coal- and ash-handling system should be as nearly dustless as possible. The products of combustion discharged to the atmosphere should be smokeless and free from dust and cinders. They should also be discharged at such a height that they will not offend those occupying offices in high buildings.

The problem of smoke abatement can be solved by proper furnace design, selection of fuel-burning equipment and operation. There is still considerable room for improvement in dust catchers.

Steam-Driven Auxiliaries Favored

Steam-driven auxiliaries are generally indicated. Steam turbine drive, if properly applied, will give ideal control for fans and pumps and be satisfactory for pulverizer and stoker drive. Geared turbines are the ideal prime movers for auxiliaries.

Simplicity should be the keynote of the piping design. Care should be exercised to see that only the heat insulation that is economically justified is applied. The last increment of thickness should more than pay the fixed charges on the cost of that increment. Quite often the insulation applied is thicker than can be justified under the conditions of operation.

Due to the low capacity factor the economic thickness of heat insulation in steam heating boiler plants will permit the radiation of a considerable amount of heat. By proper plant design a substantial portion of this heat can be recovered via the forced draft fan.

Boiler feed pumps for normal operation should be turbine-driven. The spare feed pump can be motor-driven and used for heat-balance control. If heat balance permits, other essential pumps may be turbine-driven.

The first essential of the ash-handling equipment is cheapness and small building volume requirement. The second is that it should be dustless and clean.

Economic Cause and Result

1. Low load factor does not warrant high investment.
2. High distribution cost requires location near load.
3. Location near load makes smoke prevention important.
4. Location near load, with resulting high cost of land, makes remote coal storage desirable.
5. General impracticability of returning condensate results in high make-up which, in turn, calls for water treatment.
6. Lack of bled steam favors steam-driven auxiliaries.
7. Lack of interconnection makes reliability a primary requisite.

Steam-Tight Eccentrics And Other Discoveries

THE FOLLOWING GEMS of misinformation were submitted by Prof. J. A. Dent, head of Department of Mechanical Engineering, University of Pittsburgh, Pittsburgh, Pa. "Such discoveries," says Professor Dent, "are among the alleviations of a teacher's hard life."

"The purpose of the governor is to regulate the flow of the steam through the eccentric."

"The lead is the distance the steam port moves after it is opened before it is closed."

"The mechanical equivalent of heat is the amount of work necessary to convert a pound of water into a B.t.u."

"The latent heat of evaporation is the heat to raise a pound of water from the freezing point to 32 deg. Fahrenheit."

"The eccentric is a solid disk, the hole in which is used as a crankpin."

"The lubricator is put on the steam line to grease the steam so it will slip through the pipes more easily."

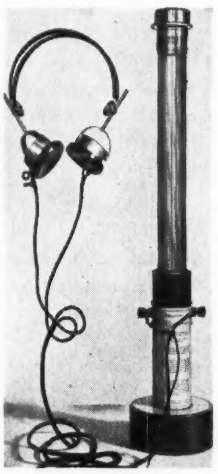
▼

A MISPLACED decimal point in the article on the La Crosse, Kan., municipal plant, on page 875 of the June 2 number, gave the yearly average operating cost per kilowatt-hour as 1.21 mills. This should have been 12.1 mills.

WHAT'S NEW IN PLANT EQUIPMENT

Device Locates Hidden Ducts and Outlets

A DEVICE by which ducts and outlets under the floor can be readily located, called the "Nepcoduct Divinator," has been announced by the National Electric Products Corporation, Pittsburgh, Pa. The divinator is employed where existing outlets are hidden by floor covering or buried in concrete. The ear readily recognizes the characteristic sounds made by the mechanism as the instrument is carried along the floor. When the divinator crosses conduit a definite sound is transmitted to the headset, and when the instrument is over an outlet, another definite sound is made.



"Nepcoduct Divinator"

Compression Fittings and Tubing for Small Service Lines

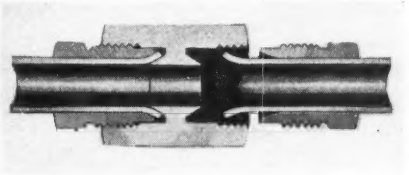
A COMPLETE LINE OF COMPRESSION fittings and tubes, designated "Dieform," has been made available by the Bailey Meter Company, Cleveland, Ohio, for use in small service lines in the power plant and industrial fields.

The illustration shows an exploded view of a tubing union which illustrates how the joint is made. The left-hand side of the union is shown with the tubes in place and the tube nut screwed down tightly to complete the metal-to-metal joint. The right-hand side shows the tube nut unscrewed and slipped back along the tubing, which, in turn, is removed a slight distance from the seat in the fitting.

In flaring the tubing the nut serves as a die, thereby assuring a perfect seat with the angle properly proportioned to the size of the tube. The moderate angle of flare prevents the tube from splitting or cracking, and also permits the use of hard-drawn tube when desirable.

Brass, monel metal or steel compression fittings and copper or steel tubing are especially well suited for piping where many bends must be made in the line and where an absolutely tight installation is required for high pressure and high temperature service.

Double, extra-heavy brass fittings

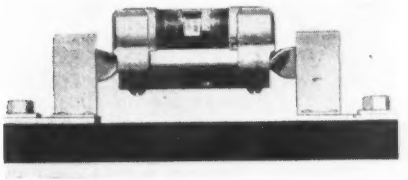


Dieform tubing union

with extra-heavy soft annealed or half-hard copper tubing are available for pressures which do not exceed 800 lb. and where the intermittent temperatures are under 600 deg. Where higher intermittent temperatures are expected steel or monel compression fittings are recommended.

Fuse Reducer for Standard Fuse Holders

OVERFUSING IS A HAZARD frequently permitted in electrical systems simply because the main switchboard and sub-distribution boards have been installed with fuse gaps of greater capacity than necessary for certain motor circuits.



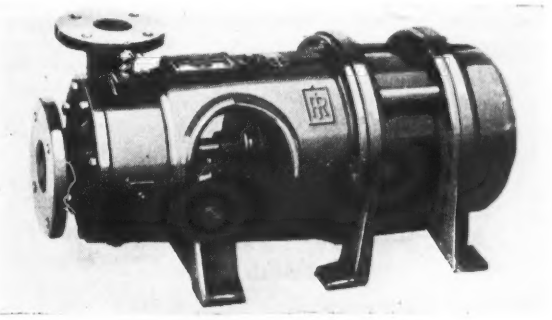
A 100 to 60 ampere fuse reducer

To obviate this hazard and permit the installation of the proper size of fuse on any circuit without the necessity of changing the fused control switch or fuse block, the Ideal Commutator Dresser Company, Sycamore, Ill., has brought out the fuse reducer illustrated.

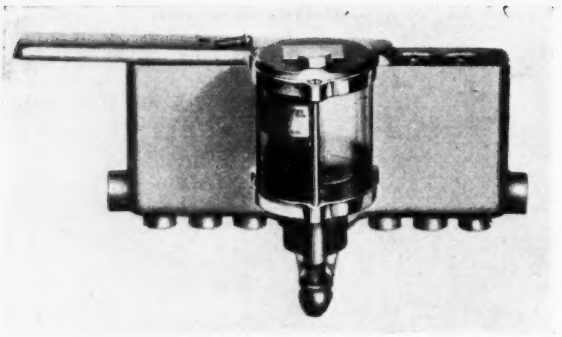
Made in several sizes for standard N.E.C. cartride fuse holders for 250 and 600-volt spacing, these reducers give wide flexibility in the use of existing circuits for various sizes of motors, as practically any reduction from the installed capacity is possible.

General-Service Centrifugal Pump

CLASS R. V. designates a new unit-type general-service pump introduced recently by the Ingersoll-Rand Company, 11 Broadway, New York City. The pump is suitable for such applications as circulating and cooling systems, standpipe and water-supply systems, industrial plants and general transfer and handling service of reasonably clear liquid. It is made in six sizes and can be furnished mounted on a structural steel bedplate to facilitate installation.



Class R. V. motor-driven centrifugal pump for general industrial service



Six outlet oil-feed unit with adjustable wicks

Adjustable Wick Oil Feed for Lubrication of Bearings

AN ADJUSTABLE WICK OIL-FEED UNIT for controlling the amount of oil delivered, from a reserve supply of $\frac{1}{2}$ pint to 2 gal., to various types of bearings has been announced by the Daun-Walter Company, Milwaukee, Wis.

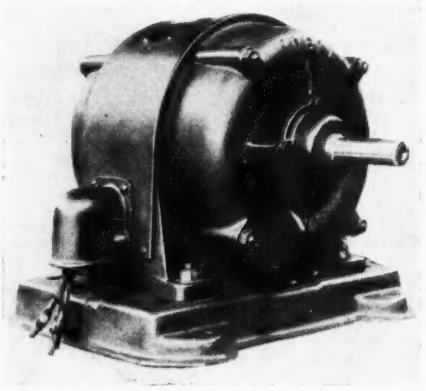
The device, as shown in the illustration, consists of the constant level oil control described in the April 21 number, and an adjustable wick oil-feed multiple unit or wick box. The wick box is of cast aluminum with a removable cover and is made in 4, 8 and 12 outlet units providing lubrication for a like number of bearings. The horizontal outlets on either end of the box enable the hooking up of other wick units when located on the same level. Provision is made for adjusting the height of the turn-down of each wick loop, which determines the quantity of oil fed by the wick. A minimum as low as four drops an hour can be maintained.

Drip-Proof Unit-Type Motor

A RECENT ADDITION to the line of motors put out by the Ideal Electric & Manufacturing Company, Mansfield, Ohio, is the drip-proof model illustrated, which is protected against water or other liquids dripping on it or being splashed in through the ends. Its action, as water is thrown into the motor, is to discharge it immediately through the vent at the bottom of the center inclosing jacket. Air circulation is from both ends toward the center and out through this vent.

Large shrouded fans just inside the end brackets at each end catch any water entering through the end of the motor and throw it against the inside surface of the bearing bracket. From here the water runs down the inside of the bearing brackets and out through the center bottom vent without coming in contact with the windings.

The outer surfaces of the motor are such that water dripping from above cannot enter the motor. The shroud cover incircling the motor at the center effectively prevents the entrance of water at that point. This cover does not completely surround the motor, but is open at the bottom to form the exhaust vent through which both air and water are discharged.



Assembly view of drip-proof motor

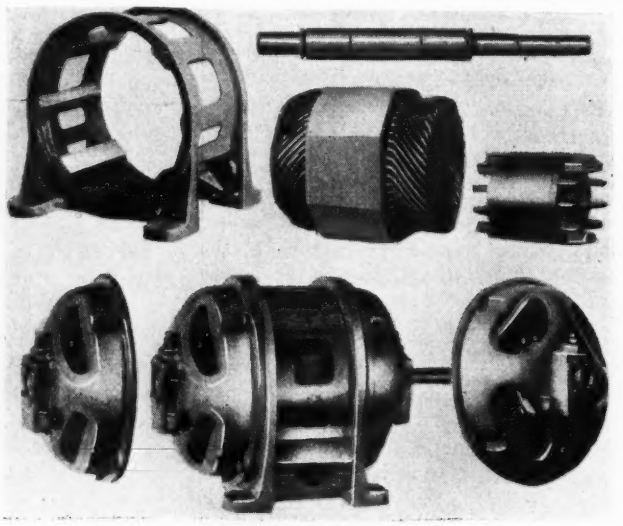
Motor Has Separable Mechanical and Electrical Parts

IN THE DESIGN of the new W-frame type CS squirrel-cage induction motor brought out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., the different parts of the motor are entirely separate units. This new design makes maintenance simpler and less expensive, because damaged electrical parts can be replaced without replacing or rewinding the motor.

In the new design the stator core containing its winding is pressed into the motor frame. When it becomes necessary to replace a damaged winding, the old core and its winding are pressed out as a unit by an ordinary arbor press and a new "prewound" core is pressed in. This operation can be performed, ordinarily, in less than an hour.

Like the stator core and its winding, the rotor is a complete separate unit; and both the rotor and the stator core and winding can be supplied as such for built-in motor or repair purposes. This feature makes it possible to vary the electrical characteristics, using the same set of mechanical parts; and, with a given set of electrical parts, the mechanical construction can be changed in almost numberless combinations.

The separate-frame construction makes it possible to supply any one of a number of different types of frames, such as vertically or horizontally mounted motors, motors without feet, and open, semi-inclosed and totally inclosed motors. The brackets are bolted to the frame with a ring-groove fit that automatically and permanently sets the air gap and aligns the bearings.



Westinghouse W-frame, type CS squirrel-cage induction motor with separable mechanical and electrical parts

NEWS of the FIELD

Southwest Power Conference and Exhibition To Be Held in Kansas City, Mo., Sept. 7-11

Engineering societies, municipal utilities, universities, power and allied industries to join N.A.P.E. meeting

DURING the week of Sept. 7 to 11 Kansas City, Mo., is to have a Southwest Power Conference in which local engineering organizations and sections of national engineering bodies in that region and surrounding states will participate. A mechanical exposition will be staged simultaneously in the Convention Hall. Starting with the annual convention of the National Association of Power Engineers and the usual power show held in connection with this meeting, as a nucleus, the Chamber of Commerce and other bodies decided to expand the program and give to Kansas City a power conference and show in which all interested groups would participate individually and collectively in a general power program lasting throughout the week.

Engineering societies, engineering departments of colleges and universities, all power industries and allied interests have been merged into the committee sponsoring the power conference. The Chamber of Commerce will devote the program of its opening fall luncheon on Sept. 9 to the problems of power. The National Association of Power Engineers will hold its national convention from Sept. 7 to 11, using the Missouri Theater, a half block from Convention Hall, for business sessions. Other groups and societies will have regional, district or state sessions.

For the first three days of the week the American Society of Mechanical Engineers will hold a regional meeting including sessions on fuel, power, oil and gas power, petroleum, aeronautics and safety. There will be state association meetings of municipal utilities of Kansas, Missouri, Iowa and Nebraska, and meetings of the wholesale and retail coal dealers associations. The Kansas City Safety Council will introduce safety practice lectures and demonstrations. Arrangements also are under way for meetings of several groups of the Middle West Division of the National Electric Light Association, and local meetings of various technical societies and student groups. Trips to industrial plants and points of interest, entertainment and additional attractions are to be coordinated into the general program.

A list of the engineering societies enrolled in the power conference follows: American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Society of Heating and Ventilating Engineers, and the National Association of Power Engineers.

Cooperating institutions are: Kansas City Power & Light Company, Kansas City, Kan., Light Department, National Electric Light Association, coal industry, gas industry, oil industry, American Railroad Association, and the Chamber of Commerce in addition to twelve universities and colleges.

Officers of the central committee coordinating these various functions are: Joseph F. Porter, honorary chairman; Albert L. Maillard, chairman; A. F. Thompson, vice-chairman; George F. Klein, secretary-treasurer.

Contracts already signed for space in Convention Hall indicate that there will be an excellent exhibition of the varied equipment necessary to produce and utilize power. Two impressive displays raised on special platforms will mount over the regular exhibit section. One of these exhibits will be installed by the Kansas City Power & Light Company. The other will be a joint exhibit of the municipal power groups from Kansas, Missouri, Iowa and Nebraska.

Hoover Dam Power too Costly For San Diego, Utility Says

THAT HOOVER DAM POWER will prove too costly for the City of San Diego, is the statement made in a letter written by W. F. Raber, vice-president and general manager of the San Diego Consolidated Gas & Electric Company, and addressed to Mayor Walter W. Austin, of San Diego. Mr. Raber advised the mayor that electrical energy could be generated locally by steam more economically, even should the government reduce its estimated charges 50 per cent. He agreed with Nelson Eckart, of the engineering department of the City of San Francisco, that the cost of Boulder Canyon power to the City of San Diego was prohibitive. The letter was in the nature of a refusal to act as an agent in bringing Hoover Dam energy to San Diego.

The Metropolitan Water District of Southern California had previously been approached by the San Diego city officials with a similar request, which was refused on the grounds that the district was in no position to guarantee San Diego that it could carry and deliver electrical energy there.

Appoint N. Y. Commission to Regulate Interstate Power

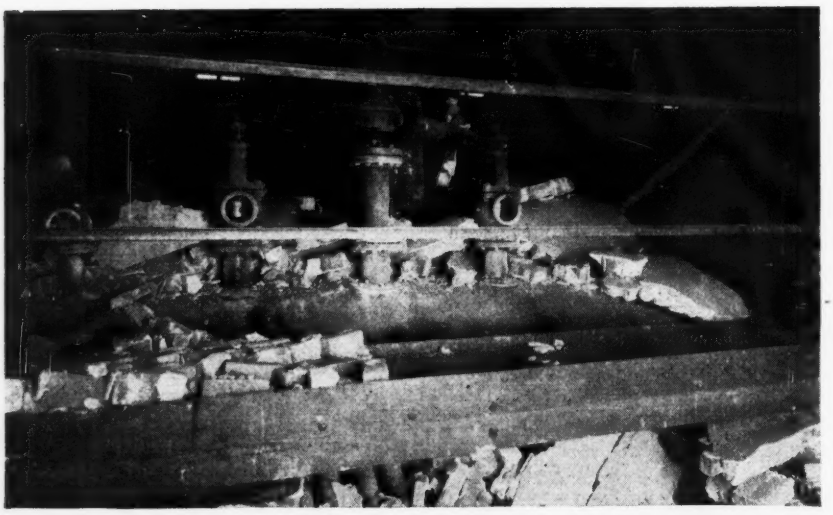
IN ACCORDANCE with the law passed at the last session of the New York State Legislature, George R. Fearon, temporary president of the Senate, and Joseph A. McGinnies, speaker of the Assembly, announced on June 20 the appointment of Senators Warren T. Thayer and Thomas C. Desmond and Assemblymen R. Foster Piper and Harry A. Reoux as legislative members of the temporary state commission to negotiate treaties with adjoining states and the Federal Government, relative to the regulation and control of utility companies engaged in interstate transmission of power.

Complete 300-Mile Gas Line Through Texas-Ariz.-Mexico

THE NEW 12-in. pipe line of the Western Gas Company, from El Paso, Texas, to Douglas and Bisbee, Ariz., and Cananea, Sonora, Mex., was put into service June 8. Construction of this 300-mile pipe line was started in February and completed the latter part of May, two months ahead of the contracted construction schedule. The completed line was successfully tested by the 24-hr. pressure drop method at 750 lb. per sq.in. The line will be operated under a pressure varying from 300 to 600 lb. per sq.in. The construction of this line cost $6,000,000.

Bechtel-Kaiser Co., Ltd., San Francisco, were general contractors on the main line construction with C. P. Bedford project manager on the job and Edgar F. Kaiser assistant manager. Ford, Bacon & Davis, New York, were designing engineers and supervised main line construction; Stone & Webster supervised engineering of compressor stations and main line construction.

EFFECT OF A GAS EXPLOSION



THE ILLUSTRATIONS SHOW the effect of a recent gas explosion in a 6,000 sq.ft. water tube boiler with integral economizer, installed in a new heating plant. The boiler is fired with No. 3 buckwheat anthracite on a chain-grate stoker.

The explosion occurred about five minutes after starting the fan to bring the boiler out of bank in the usual way. The fireman, standing directly in front of the boiler coaling the one opposite, heard a hissing sound and noting a yellow cloud crowding out about his feet escaped down the aisle. He had only covered 30 ft. when he heard the crash of falling brick. This was the only report heard by others in the building. There was no distinct concussion.

Brick, dislodged from over the front drum, showered down where the fireman had stood when he received the warning. The explosion apparently took place near the uptake. The coal and ashes on the grates were not disturbed.

This explosion brings up the question of the type of catches that should be used on the access doors of the setting. As at present interpeted the boiler code of the State of New York requires that the catches on doors of water-tube boilers located less than 7 ft. above the floor be so arranged as to automatically secure the door when closed so that the bursting of a tube cannot open it. The easy opening of other access doors might have provided relief in this case.

▼ ▼ ▼

Utah Utility Files Suit Against Idaho Power Tax

UTAH POWER & LIGHT COMPANY has filed suit in the Federal Court at Boise, Idaho, for an injunction to prevent collection of the tax of one-half mill per kilowatt-hour on all electric power generated for sale in the state of Idaho, which tax was embodied in a law passed at the last session of the Legislature.

The suit, which named Emmit Pfost, commissioner of law enforcement, and Attorney General Fred Babcock, as defendants, attacked the constitutionality of the act and of the call of Governor C. Ben Ross for the special session of the legislature which enacted the law. The suit asked for an interlocutory injunction and hearing before three federal judges at an early date. The urgency of the matter was pointed out, in that the law calls for a report by July 15 of power generated during June, for taxing purposes.

The law is unconstitutional, the suit stated, in that it interferes with interstate commerce by taxing a commodity which goes instantly into interstate commerce when generated; that it deprives the company of the right to equal protection of the law through assessing a special tax upon it; that it provides a tax for one special group when it requires the company generating the power to return to irrigators and drainage users all the tax that has been collected on the power used by them in pumping projects. Moreover, it is assailed as a double tax in that the company is already paying a license tax, a property tax, and an income tax.

Levying of the tax would cost the power company approximately $120,000 a year, the suit stated, while very little of the power generated is used in Idaho, most of it going to Utah.

Municipal Plants May Sell Surplus Power, Court Says

ACCORDING to an opinion rendered in Tacoma, Wash., by Superior Judge W. C. Chapman of Pierce County, in a friendly test suit brought by the Bremerton Municipal League to settle the question, municipalities manufacturing electricity can dispose of any "surplus power" outside their corporate limits, and should not be restrained from making contracts with other municipalities for buying such surplus.

The opinion places legal approval upon a practice which has been carried on by cities having power to sell for years under a kind of "gentlemen's agreement" with privately owned companies. Tacoma has sold its surplus of power to industries and plants outside of its limits, both at La Grande and Chambers Creek.

While the legality of this practice has always been questioned, this is the first time the issue was raised in court and sent to the Supreme Court for adjudication. Seattle has "traded" or "exchanged" surplus power with Tacoma for several years.

Defendants in the action included Seattle, Tacoma, Centralia, Puyallup and Bremerton. The Municipal League challenged the right of Bremerton to buy power from Tacoma and complained that until such question had been passed upon by the courts of the state, Bremerton could not dispose of its municipal utility bonds.

Standards Urged for "Clean" Bituminous Coal

A REQUEST has just been received by the American Standards Association from the American Institute of Mining and Metallurgical Engineers to initiate a project for the establishment of standards for "clean bituminous coal."

In a letter urging the desirability of setting up such standards, Howard N. Eavenson, chairman of the coal division of the institute, writes that in some sizes and kinds of coal now "sold as 'clean' coal there may be 0.5 per cent impurities, while others may contain 4 per cent. It is obvious that the mine shipping 'clean' coal on the minimum impurity basis is handicapped in competing with one shipping a larger amount, although both products may have been cleaned. In these days of price competition all of these items count, and an agreed-upon basis will be of help not only to the shipper, but also to the consumer, who will then for the first time know what he may expect when he buys 'clean' coal and will have a standard by which he can measure it."

The question of the initiation of this work will be submitted to the A.S.A. Standards Council at an early date, and if the initiation of the project is approved by the council work will be undertaken by a technical committee.

World Power Conference Publishes Bibliography

IN RESPONSE to the need for a comprehensive and authoritative survey of current information on power, fuel and related subjects, the World Power Conference has arranged for the publication of the first international bibliography in this field.

The British section of the bibliography, known as the *Power and Fuel Bulletin*, is now being published on the 25th of each month, and copies may be obtained from the British National Committee, World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2, England. Included in its contents are abstracts of recent books, papers, articles, etc., on the sources, generation, distribution and utilization of power.

Germany, Japan and the United States are preparing similar bulletins, and it is expected that the other member-countries will do the same. The bibliographies will be in one of the three official languages of the World Power Conference, viz., English, French or German. The extracts will be indexed in accordance with the universal decimal classification system, which makes it possible to amalgamate into a single index all contributions.

Simplified Practice Used By 10,000 Organizations

MORE THAN 10,000 different associations and firms are now listed by the division of simplified practice of the National Bureau of Standards as acceptors of simplified practice recommendations, according to a recent announcement of Edwin W. Ely, chief of that division.

There are now in effect over 120 simplified practice recommendations, and the total number of acceptances to all recommendations number nearly 30,000.

Savings, due to the application of simplified practice recommendation, according to responsible sources in the various industries affected, total more than $250,000,000. Individual firms have reported that they are saving thousands of dollars annually.

C. E. Skinner Elected President of A.I.E.E.

CHARLES E. SKINNER, assistant director of engineering of the Westinghouse Electric & Manufacturing Company, was elected president of the American Institute of Electrical Engineers for the administrative year beginning Aug. 1, at the annual business meeting of the institute held in Asheville, N. C., June 22, during the summer convention.

Other officers elected were: Vice-Presidents, W. B. Kouwenhoven, Johns Hopkins University; W. E. Freeman, University of Kentucky; Paul H. Patton, Northwestern Bell Telephone Company; A. W. Copley, Westinghouse Electric & Manufacturing Company, San Francisco; L. B. Chubbuck, Canadian Westinghouse Company—Directors, L. W. Chubb, Westinghouse Research Laboratories; B. D. Hull, Southwestern Bell Telephone Company; H. R. Woodrow, Brooklyn Edison Company—National Treasurer, W. I. Slichter, Columbia University.

The annual report of the board of directors, presented at the meeting, showed a total membership on April 30, 1931, of 18,334. In addition to three national conventions and five district meeting, 1,628 meetings were held during the year by the local organizations of the institute in the principal cities and educational institutions in the United States, Canada and Mexico.

Charles E. Skinner

Annual Safety Awards to Be Made at Hoover Dam

WITH THE OBJECT of encouraging the conservation of lives of workmen on the Boulder Canyon project, the Florence Nightingale Institute of Honorables of the United States of America proposes to confer not less than six honorary fellowships annually during the period of the construction work on those in actual charge whose records show the least number of fatalities on their portion of the job. This announcement was made recently by Col. Perry W. Weidner, president of the Academy of Regents of the institute, who stated that it was actuated solely by humanitarium considerations.

The awards will be designated as "The Edward G. Sheibley Awards for the Conservation of Human Life at Boulder Dam," and will consist of certificates printed on parchment.

Already three deaths and thirteen serious injuries have occurred in the construction of the project, the announcement states, but it is hoped that vigilant supervision will prevent any more serious accidents.

News of Canada

Chats Falls plant nearing completion—New plans for White Mud Falls—Further developments in Manitoba

RAPID PROGRESS is being made on the installation of the first two generators of the Chats Falls hydro-electric development on the Ottawa River, 35 miles west of Ottawa. The two generators with their accompanying waterwheels, each of 28,000 hp., are well along toward completion and the progress being made on the contract for the dam and power house indicates that power will be delivered to Toronto on Oct. 1.

The Chats Falls power development rates as one of the largest hydro-electric developments in Canada. It is a joint undertaking of the Ontario Hydro-Electric Power Commission and the Ottawa Valley Power Company, the former owning the water rights in Ontario and the private company similar rights in the province of Quebec. Between them they are constructing a dam across the Ottawa River nearly three and a half miles in length. This dam is now approximately two-thirds completed and when the remaining gap is closed it will provide a normal head of 53 ft. of water for the operation of the plant. The eight units comprised in the initial installation will develop 224,000 hp., while, with the addition of an extra waterwheel and generator at either end of the power house, for which provision is being made, the ultimate capacity in the ten units will be 280,000 horsepower.

THERE ARE PROSPECTS that a big hydro-electric development will be carried out in the near future at White Mud Falls on the Churchill River, in the province of Manitoba where, it is claimed, 400,000 hp. may be developed. The Dominion Power Company recently announced it was practically assured of a market at the outset for 40,000 hp. Of this amount 30,000 hp. would be taken by the Saskatchewan Power Commission, provided the contract price is right. A market for an additional 10,000 hp. is also reported to be assured. With such sales provided for, it is stated that the company would be warranted in putting in the first unit of a power plant.

The company has not been granted a renewal of its permit for the power site which expired on May 15. It has, however, been assured by the provincial authorities, that its application would not be prejudiced by the delay of the government in dealing with the matter.

FURTHER DEVELOPMENTS in the province of Manitoba show many evidences of vitality. The Winnipeg Electric Company's big power project at the Seven Sister Falls, which entails a total expenditure of some $23,000,000, is rapidly nearing completion. The initial de-

velopment providing for the generating of 112,000 hp. will be completed this year. Six generators will be installed, each capable of producing 37,500 hp. The provincial hydro department is about to commence construction work on the western extensions of its system which will carry its line west of Brandon, as far as Virden.

Seattle Light Dept. to Cut Operating Costs $200,000

OPERATING COSTS of the City Light Department, Seattle, Wash., under a plan which Mayor Frank Edwards and Superintendent W. Chester Morse are now working out, will be cut about $200,000 in 1932, the Mayor states. The economy plan will be effected without throwing any employees out of work, and part of the expense-cutting, it is stated, will go into effect during the latter part of 1931, so that a large portion of the City Light operating apportionment for 1931 may be turned back to relieve the budget of 1932.

"The saving is to be accomplished by transferring many employees of the much overmanned operating division to the construction division," Mayor Edwards explained. "There will be a vast amount of construction under way to absorb the excess personnel now employed on operating details. This will include clearing right of way for the new Skagit power transmission line and building of that line, nearly 120 miles, from City Light's Skagit development to Seattle, at a cost of $1,500,000."

New England Council Starts Stabilization Campaign

A CALL to all industrial and trade associations in New England to form committees on stabilization and industrial planning, to attack the problems of employment fluctuations, and to coordinate the ideas and experience of all units within given industries, has been issued by the industrial committee of the New England Council.

In a letter to the presidents of all such business organizations, James W. Hook, of New Haven, Conn., chairman of the committee, urges that these stabilization committees be set up and proceed at once along four lines:

1. Review and exchange information as to what members have done, or are doing toward reducing or avoiding instability in employment.
2. Examine what other industries have accomplished in this direction.
3. Develop stabilization programs which will assist members to operate with greater regularity.
4. Adopt and encourage record-keeping that will show precisely how weekly hours of work and wage earnings of individual employees have been affected by the current depression.

COMING CONVENTIONS

American Society of Mechanical Engineers. Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society. Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Smoke Prevention Association. Annual meeting at the Hotel Pantlind, Grand Rapids, Mich., June 30-July 3. Secretary, Frank A. Chambers, City Hall, Chicago, Ill.

Southwest Power Conference and Show will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

William L. Saunders Dies

WILLIAM LAWRENCE SAUNDERS, chairman of the board of the Ingersoll-Rand Company and one of the country's foremost engineers, died June 25 at Teneriffe, Canary Islands, while on a cruise around the world. Born at Columbus, Ga., on Nov. 1, 1856, Mr. Saunders was a graduate of the University of Pennsylvania. He became interested in the application of compressed air to engineering problems and for a time edited *The Compressed Air Magazine*. He invented the radialaxe system for coal mining and the method of pumping liquids by compressed air. For many years he was president, and ultimately chairman, of the Ingersoll-Rand Company. He was a past president of the American Institute of Mining and Metallurgical Engineers.

Personals

ROY V. WRIGHT, president of the American Society of Mechanical Engineers and managing editor of *Railway Age*, received the honorary degree of doctor of engineering from Stevens Institute of Technology at the recent 59th annual commencement exercises of the institute.

R. D. BEAN, formerly manager of the engineering development department of the Brown Instrument Company, Philadelphia, has been made chief engineer of the company. Mr. Bean's extensive investigations covering the industrial applications of measuring instruments has won him wide recognition in that field.

STANLEY STOKES, who has been actively associated with the operations of the Union Electric Light & Power Company, St. Louis, and its subsidiaries for a number of years, has recently been appointed consulting electrical engineer of the company. Since 1927 Mr. Stokes has served as power supervisor and chief electrical engineer of the company.

DR. HARRIS J. RYAN, for the past 25 years head of the department of electrical engineering of Stanford University, ended his teaching career on June 15 and became emeritus professor of electrical engineering and honorary director of the high-voltage laboratory named in his honor. His retirement from academic routine will leave Dr. Ryan free to devote his entire efforts to electrical research, a prodigious amount of which he has carried on and directed during his 43 years as a teacher. His research work has covered practically the entire field of electrical engineering from the development of direct-current machinery to high-voltage long-distance transmission of power.

JOHN H. BICKLEY, who until last May was public utility specialist with the Federal Trade Commission and engaged in planning and directing that body's utility inquiry, has been placed in charge of the accounting and finance department of the Public Service Commission of Wisconsin. SAMUEL MEISELS, formerly employed as examiner by the Federal Power Commission and the Federal Trade Commission, has been engaged by the Wisconsin commission as special investigator.

GEORGE M. RICHARDSON, purchase engineer of the Southern California Edison Company, was elected president of the National Association of Purchasing Agents, at the recent convention of that organization held in Toronto, Canada. This is the first time that a Western man has been selected for the presidency of the association, which has a membership of more than 6,000 and is said to represent a buying power of over $800,000,000 a year.

Business Notes

Stockholders of the AMERICAN BROWN BOVERI ELECTRIC CORPORATION, Camden, N. J., have approved the sale of the company's electrical manufacturing business to the ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., for $600,000 cash and 62,000 shares of Allis-Chalmers capital stock. The deal includes sale of the CONDUIT ELECTRICAL MANUFACTURING CORPORATION and the electrical patents and certain other electrical assets of the American Brown Boveri company.

KENNEDY VALVE MANUFACTURING COMPANY, Elmira, N. Y., announces the removal of its Los Angeles, Calif., office to 706 Bendix Building.

ARMSTRONG CORK COMPANY, Lancaster, Pa., has consolidated all of its Boston, Mass., branch sales offices and warehouses in one office located at 286 Congress St., according to an announcement of the company.

L. MUNDET & SON, New York City, announces that hereafter its selling organization throughout the United States will be operated under the name of MUNDET CORK CORPORATION. Accompanied by no change in sales policy, the change of name is made solely to identify the company with its chief product, it is stated.

MOELLER INSTRUMENT COMPANY, Brooklyn, N. Y., announces the appointment of the following new sales representatives: Philip D. Rech, 215 East Church Rd., Elkins Park, Pa.; E. C. Shriner, 1710 Potomac Ave., South Hills, Pittsburgh, Pa.; and the Paper Mill Equipment Company, Northwestern Bank Bldg., Portland, Ore.

ILLINOIS STOKER COMPANY, Alton, Ill., announces the appointment of Robert Lacy, 604 Chamber of Commerce Bldg., Pittsburgh, Pa., as its representative in that territory.

GENERAL ELECTRIC COMPANY, Schenectady, N. Y., announces the completion of a new $1,000,000 arc-welded transformer tank shop at its Pittsfield, Mass., plant. The building, which is 550 ft. long and 150 ft. wide, was finished in less than seven months after ground was broken. More than 1,500 tons of structural steel united with over 5,000 linear feet of electrical welds form the framework of the new shop.

THE MERIAM COMPANY, Cleveland, Ohio, announces that H. R. Bowers, formerly with the BAILEY METER COMPANY, has been made manager of sales and advertising. The company also announces the appointment of the Anderson Engineering Company, 42 Church St., New Haven, Conn.; Leonard Maleson Company, 815 Locust St., Philadelphia, Pa.; and S. D. Shook & Company, 528 Duquesne Way, Pittsburgh, Pa., as exclusive representatives in their respective territories.

How's Business?

THE SWIFT, sweeping reversal of psychology in world security and commodity markets should be a sufficient word to the wise. It has suddenly exposed the paralyzing doubt and deflationist dogma that have dominated and unduly prolonged this depression; given a glimpse of the vast forces of potential financial power, deferred demand and postponed enterprise that can catapult business into unparalleled expansion again, once they are released by intelligent leadership and recuperating confidence. This surge of speculative sentiment in the past week swamps the slow, stagnant statistics of business activity which, in our index up to June 20, showed a sharp drop to a new low level, with steel, carloadings and even check transactions sagging under orthodox summer slackness. But prices have become the key to recovery, and the scramble of empty inventories and idle investment funds to get on the bus before it starts back to normal value levels is likely to leave business indicators behind for a while.—*The Business Week*, July 1.

Trade Catalogs

GAS BURNERS—Bulletin No. 305-A, recently issued by the Denver Fire Clay Company, P. O. Box 1107, Denver, Colo., presents details of construction, installation and operation of Type A refractory gas burners.

REFRACTORY CEMENT — Applications of "Kromepatch" for bonding fire-brick are described and illustrated in a new folder of E. J. Lavino & Company, Bullitt Building, Philadelphia, Pa.

WATER-TUBE BOILERS — Bulletin WT-3, recently issued by the Henry Vogt Machine Company, Louisville, Ky., contains full information on the company's line of water-tube boilers, which includes three-drum curved-tube, four-drum curved-tube, low-head curved-tube, and waste-heat types. Many illustrations, diagrams and tables are included in its 63 pages.

DIESEL ENGINES—A new illustrated bulletin on solid-injection diesel engines has just been issued by the Ingersoll-Rand Company, 11 Broadway, New York City. It discusses the advantages of diesel power, and contains a general description of I-R diesels ranging in capacities from 150 to 1,200 horsepower.

PUMPS — Bulletin No. 139, recently issued by the Morris Machine Works, Baldwinsville, N. Y., describes and illustrates a line of non-clogging centrifugal pumps for sewage and industrial services. Full details of construction and operation are included in the bulletin.

MOTORS — Seven distinct types of squirrel-cage motors are described in Bulletin No. 165 recently issued by the Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo. The speed-torque curves and tables given make a thorough comparison possible, thereby enabling the buyer to select the proper type for each application.

SWITCHES—Allen-Bradley Company, 284 Greenfield Ave., Milwaukee, Wis., has just published a number of supplementary bulletins and price sheets to be inserted in the company's general catalog. These bulletins cover contactors, starters and various switches.

▼

Fuel Prices

FUEL OIL

Boston—June 22, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.83c. per gal.

New York—June 25, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 5c. per gal.

Philadelphia—June 23, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—June 17, f.o.b. local refinery, fuel oil, 30@34 deg., 2.5c.@2.625c. per gal.; 36@40 deg., 2.5c.@2.625c. per gal.

Cincinnati—June 23, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—June 17, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 30c. per bbl.; 22@24 deg., 35c. per bbl.; 24@26 deg., 40c. per bbl.; 26@28 deg., 47.5c. per bbl.; 28@30 deg., 55c. per bbl.

St. Louis—June 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.095 per bbl., or 42 gal.; 26@28 deg., $1.17 per bbl.; 28@30 deg., $1.245 per bbl.; 30@32 deg., $1.345 per bbl.; 32@36 deg., gas oil, 2.526c. per gal.; 38@40 deg., distillate, 3.151c. per gal.

Dallas—June 20, f.o.b. local refinery 24@26 deg., 80c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.65 @$1.85
Pool 10, h. gr. low-vol.	New York	1.50 @ 1.65
Pool 11, low-vol.	New York	1.40 @ 1.50
Smokeless, mine-run	Chicago	1.50 @ 1.75
Smokeless, slack	Chicago	.60 @ 1.10
Harlan, Ky., slack	Chicago	.85 @ 1.10
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.25 @ 1.75
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.25 @ 1.40
W. Ky., mine-run	Louisville	.85 @ 1.25
W. Ky., slack	Louisville	.60 @ .85
Pittsburgh, mine-run	Pittsburgh	1.35 @ 1.45
Smokeless, mine-run	Cincinnati	1.65 @ 1.75
Smokeless, slack	Cincinnati	.75 @ 1.25
Kanawha, mine-run	Cincinnati	.90 @ 1.25
Kanawha, nut-slack	Cincinnati	.50 @ .90

Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.10 @$3.25
Barley	New York	1.00 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., El Centro—Barbara Worth Hotel Corp. Ltd., is having plans prepared for remodeling hotel including new addition, store rooms, refrigeration system, kitchen equipment and power plant at 7th St. and Broadway. Estimated cost $250,000. D. W. Wells and R. Swearington, 110 North 6th St., are architects.

Calif., Los Angeles—Legal Tower Ltd., First St. and Broadway, is having plans prepared for a store and office building. Estimated cost $2,000,000. A. Curlett, 1012 Union Bank Bldg., is architect.

Conn., Southington — Lake View Farm, H. Rogers, Mgr., is receiving bids for the construction of a 68 x 95 ft. cold storage plant. Estimated cost $40,000. L. J. Thompson, 521 Corbin Ave., New Britain, is engineer.

D. C., Anacostia—Bureau of Yards & Docks, Navy Dept., Washington, received low bids for barracks and boiler plant at Naval Air Station here.

Idaho, Lewiston—Northwest Cities Gas Co., has work under way on a gas generator and gas holder, by day labor. Estimated cost $100,000. Engineer not announced.

Ia., Cedar Falls — Bd. of Education, W. H. Gemmill, Secy., Capitol Bldg., Des Moines, awarded contract for the construction of a 54 x 135 ft. heating plant at Iowa State Teachers College to Tapager Construction Co., Albert Lea, Minn., $89,966.

Ia., Lake Mills—City, J. D. Kent, Clk.,, plans an election July 1 to vote $90,000 bonds for the construction of a light and power plant.

La., New Orleans—Charity Hospital, F. W. Mathews, Secy., will soon award contract for constructing and equipping refrigerating and ice manufacturing plant including one vertical single acting double cylinder ammonia compressor, double ammonia receiver, freezing tank, etc. Estimated cost $25,000.

Mass., Chatham—Chatham Water Co., plans the construction of a new waterworks system, including pumping station. A. S. Dowing, 89 Broad St., Boston, in charge.

Mass., Palmer — Commonwealth of Massachusetts, Dept. of Mental Diseases, is having preliminary plans prepared for the construction of a heating plant at Monson State Hospital. Estimated cost $300,000. E. C. Brown Co., 77 Summer St., Boston, is engineer.

Mass., Pittsfield—Pittsfield Electric Co., C. E. Merrill, Pearl St., plans the construction of a 3 story service building, office and garage at Pearl and Renne Ave. Estimated cost to exceed $75,000. Private plans.

Minn., Minneapolis—Spencer Kellogg & Sons, 822 Flour Exchange, awarded contract for addition to grain elevator, 1,000,000 bu. capacity including 14 tanks at 25th St. and University Ave. S. E. to Fegles Construction Co., Wesley Temple Bldg. Estimated cost $100,000. Equipment including conveyor system and one power operated automatic shovel will be required.

Mo., St. Louis—Midwest Industrial Development Co., subsidiary of Illinois Terminal R.R., A. P. Titus, V. Pres., 1221 Locust St., awarded contract for superstructure of a 17 story terminal warehouse at High and Morgan Sts. and Lucas Ave. to Selden-Breck Construction Co., Fullerton Bldg. Estimated total cost $5,000,000.

N. J., Elizabeth—Joint Meeting, S. H. Rollinson, Chn., City Hall, Newark, will receive bids until July 16 for joint sewage treatment plant and appurtenant structures, divisions A. to D. having a settling tank, capacity of 50 m.g.p.d. and maximum capacity of 172.5 m.g.p.d., including pumps, ejectors, compressors, traveling crane, etc., for townships of Hillside, Irvington, Maplewood, Millburn, Union, West Orange and cities of East Orange, Newark, South Orange, Summit and Borough of Roselle Park. A. Pottery, 50 Church St., New York, is chief engineer.

N. J., Hawthorne—Sands Bros., 1099 Goffle Rd., will not rebuild ice plant at Goffle and Rock Rds. $40,000. Project abandoned.

N. J., Linden — Bd. of Council, City Hall, plans the construction of a sewage disposal plant and pumping station. Estimated cost $25,000. Engineer not selected.

N. J., Newark—Public Service Electric & Gas Co., Terminal Bldg., is having plans prepared for the construction of a 40 x 110 ft. electric sub-station on Springfield Ave. Estimated cost $115,000. Private plans.

N. J., Paterson—Great Atlantic & Pacific Tea Co., Sherman Ave.,Newark, will soon award contract for a 1 and 2 story addition to warehouse on Railroad Ave. Estimated cost $150,000. Private plans. Owner will take bids later on boiler, stack, refrigeration machine, incinerators, etc.

N. Y., Dannemora—Dept. of Correction, State Office Bldg., Albany, will soon award contract for addition to water supply, including pump house, chlorinator house, etc., at Clinton Prison and Dannemora State Hospital here.

N. Y., Rockway Point (sta. Brooklyn) — Rockaway Operating Co., 421 7th Ave., New York, will build a 48 x 48 ft. pumping station at Roxbury, Rockaway Point. $15,000. Work will be done by day labor.

O., Columbus—Bd. of County Commissioners, Franklin Co., F. L. Donnally, Clk., will soon award contract for alterations and additions to power and heating plant at Franklin County Court House.

S. D., Aberdeen—State of South Dakota, J. Berg, State Engr., Pierre, will receive bids until July 10, for the construction of a new boiler house and engine house, including 370 hp. boiler at Northern State Normal and Industrial School here. Estimated cost $100,000. C. Fossum, Aberdeen, is engineer.

Tex., Borger—City plans the installation of a new gas distribution system including booster station, etc. Estimated cost $140,000. W. P. Miser, 2223 B. Polk St., Amarillo, is engineer.

Tex., Brownsville—City, c/o R. B. Renfro, Mayor, has work under way on extension to power and light plant. $150,000. G. W. Rogers, Brownsville, is engineer.

Vt., Bennington — State of Vermont, State House, H. T. Johnson, Montpelier, will receive bids until July 7 for the construction of a heating plant, including two new boilers and radial chimney at Soldiers Home here. Estimated cost $50,000. F. L. Austin, 240 College St., Boston, Mass., is architect. A. S. Kellogg, 685 Boylston St., Boston, is engineer.

Va., Richmond—Constructing Quartermaster, Fort Monroe, will receive bids until July 14 for a heating plant for barracks at Langley Field.

Ont., Ottawa—Ottawa Light, Heat & Power Co., J. Bronson, plans additional buildings and power units to plants. Estimated cost $1,000,000.

Que., Montreal — Royal Victoria Hospital, awarded contract for a 32 x 70 ft. addition to power house on Pine Ave. $19,000. Owner is in the market for equipment.

Hawaii, Oahu—Bureau of Yards & Docks, Navy Dept., received low bids for development of naval ammunition depot, including 131 buildings, 11¼ mi. railroads, 14¾ mi. paved roads, electrical, telephone and water supply systems here.

Equipment Wanted

Electric Light Plant Equipment—Ocala, Fla.—City Council, J. R. Martin, Mgr., will receive bids until July 7, for furnishing and installing equipment for electric light plant.

Pump, Generator—Muncie, Ind.—City, C. E. Stewart, Supt. of Public Works, new 7,000,000 g.p.m. turbine centrifugal pump and 100 kw. genegrator for proposed waterworks improvements. Estimated cost $200,000.

Pump, etc.—Grove City, Pa.—Borough of Grove City, will receive bids until July 10 for sewage pump, etc., in connection with sewage system.

Pumps, etc. — Gladewater, Tex. — City, c/o B. F. Phillips, Mayor, plans to purchase service pumps, etc. in connection with proposed waterworks.

Pumps, Blowers, Air Compressors, etc.—Chicago, Ill.—Sanitary District of Chicago, J. J. Sullivan, Clk., 910 South Michigan Ave., will receive bids until July 16 for pumps and blowers, electrical controlling and switching apparatus, auxiliary machinery and apparatus, including air handling equipment, air compressors, vacuum pumps, heating and ventilating systems, etc., for Calumet Sewage Treatment Works Extension, Division C.

Industrial Projects

Ind., Evansville — Sunbeam Electrical Mfg. Co., is receiving bids for addition to factory on West Morgan St. Estimated cost $40,000. Private plans.

Mass., Everett — Merrimac Chemical Co., Chemical Lane, awarded contract for the construction of an alum processing plant to J. F. Griffin Co., 250 Stuart St., Boston. Estimated cost $40,000.

Mass., Stoughton—Panther Rubber Co., 56 Monk St., will build a 2 story, 60 x 84 and 60 x 160 ft. factory on Monk St. Estimated cost $40,000. Schein & Levine, 333 Washington St., Boston, are architects. Work will be done by owner's forces.

Mo., St. Louis—Doane Carton Co., 912 North Market St., will build a 1 story, 60 x 80 ft. addition to factory at 912 North Market St. Estimated cost $50,000. Clymonts & Heinicke, 721 Wainwright Bldg., are architects. Work will be done by separate contracts. Concrete work, etc. awarded to A. L. Rascher Construction Co., 4108 Clayton Ave.

N. Y., Maspeth—Circle Flexible Conduit Co., 24-44 Woodward Ave., awarded contract for the construction of a 1 story, 94 x 100 ft. factory at Woodward and Flushing Aves. to H. Rosen, 242 Sumner Ave., Brooklyn. Estimated cost $40,000.

N. Y., New York — Kohler & Campbell, 601 West 50th St., manufacturers of pianos, plans a 6 story, 100 x 125 ft. addition to factory at 627 West 50th St. Ross & McNiel, 274 Madison Ave., are architects.

O., Massillon—Republic Steel Corp., Youngstown, plans $300,000 expansion program at Central Alloy Division, including steel strip plant to manufacture stainless steel. Private plans. New equipment will be required. Maturity Dec. 1.

O., Zanesville—Weller Pottery Co., awarded contract for addition to plant No. 3, doubling capacity of present plant to Austin Co., Union Trust Bldg., Pittsburgh, Pa. Estimated cost $100,000.

Pa., Erie—General Electric Co., East Lake Rd., had plans prepared for addition to plant for production of electric refrigerating equipment. Estimated cost $60,000.

Pa., Philadelphia—Boyertown Burial Case Co., E. L. Mory, Pres., 1211 Arch St., awarded contract for the construction of a 3 story, 34 x 112 ft. factory at Florist and Juniper Sts. to G. H. Haebner, 1231 Vine St. Estimated cost $75,000.

Pa., Scranton—Princeton Rayons' Inc., 150 Madison Ave., New York, N. Y., will receive bids about January 1 for the construction of a rayon factory here. Estimated cost $300,000.

Tex., Fort Worth—Sinclair Companies, Fort Worth National Bldg., plans remodeling and improvements to old Pierce refinery plant. Estimated cost $2,000,000. Work to start about July 1.

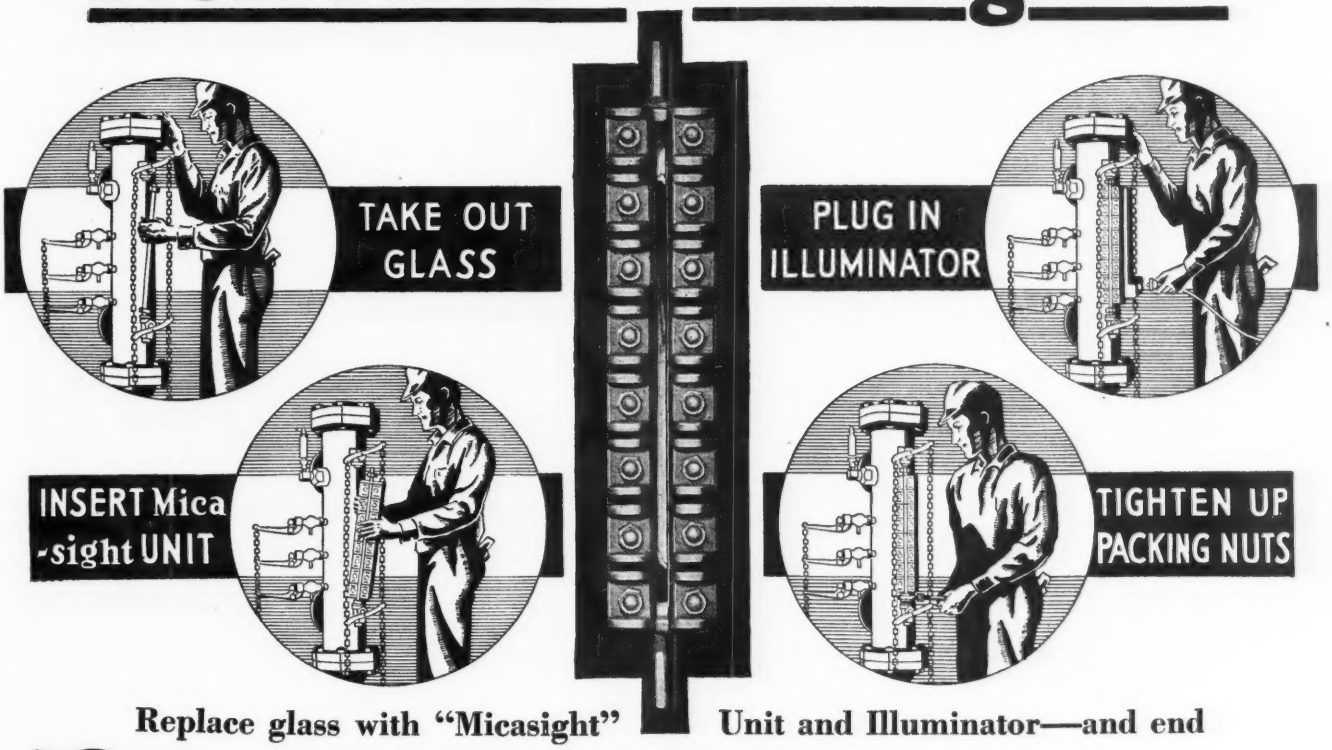
Wash., Seattle—Wire Rope Mfg. & Equipment Co., subsidiary of Puget Sound Machinery Depot, 322 First Ave., S., plans to rebuild plant for the manufacture of special rope making equipment. Loss $150,000.

Wis., Madison—Dept. of Agriculture, Washington, D. C., will receive bids until July 21, for the construction of a forest products plant to include vacuum pumps, boiler feed pumps, coal pulverizers, boilers and trimmings, soot blowers, air compressors, sump pumps, feed water heaters and regulators, etc. here. Estimated cost $700,000. Holabird & Root, 333 North Michigan Ave., Chicago, Ill., are architects.

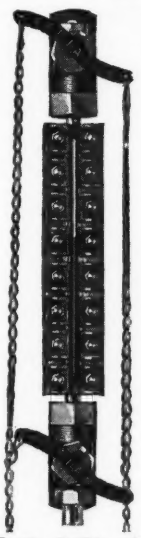
Ont., Toronto—Mack Trucks of Canada Ltd., A. V. Harburn, Gen. Mgr., 1933 Yonge St., plans the construction of a plant. Estimated cost $100,000.

Convert your Present Glass Gauges into

Reliance "Micasights"



Replace glass with "Micasight" Unit and Illuminator—and end all glass breakage troubles, at any pressure



Tough, flexible mica instead of brittle glass, no stresses, no adjustments — that's the idea behind the unbreakable Reliance "Micasight" Water Gauge.

YOU can enjoy the security of Micasight without scrapping your present water gauges. Take out the tubular glass—put in the Micasight unit with its illuminator. There's no intricate adjusting, no lining up. Regardless of pressure, you have an unbreakable gauge, free from danger of explosion or being out of commission for troublesome repairs.

There is no threat whatever from stresses fatal to glass. The flexible mica distributes any uneven tension. Micasight is free from clouding by corrosion —clear, visible, dependable, safe. If, after long service, a new mica window is needed, just insert it and screw the hex nuts up tight.

It will pay you to investigate this new water gauge safety. Write for complete information.

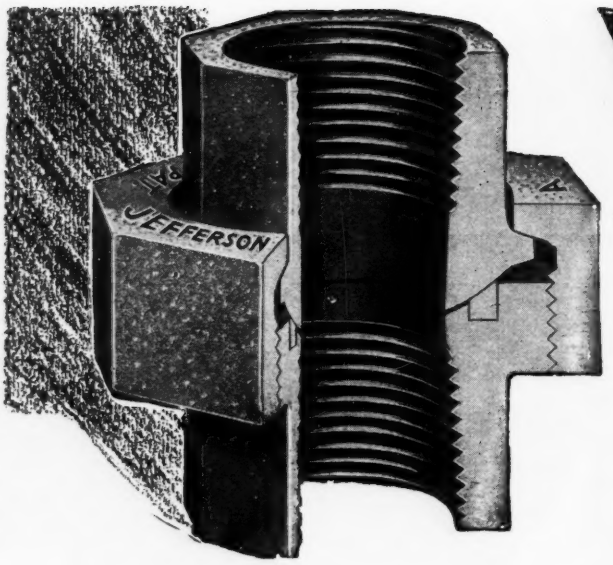
THE RELIANCE GAUGE COLUMN COMPANY
5924 Carnegie Ave., Cleveland, Ohio

The Reliance Monel Float is one of Reliance's greatest contributions to water column efficiency. It is strong, seamless, non-porous, non-corroding, proof against extreme pressures and temperatures, unsinkable in service. It makes the Reliance Column super-sensitive and instantaneous in action.

Reliance

TRADE MARK REG. IN U.S. PAT. OFF.

SAFETY WATER COLUMNS



Jefferson Features

Made of Air Refined Malleable Iron.

Brass Seat Ring located in a recess away from the runway of the fitting (patented feature).

Briggs tapered pipe threads.

Large amount of play in the ball end (an especially valuable feature when pipes are not in line).

Joints ground in pairs (self-seating and absolutely tight).

Begin NOW!

Begin *now* to re-equip all troublesome union-points in your piping with genuine Jefferson Unions. Then you won't have to battle against tremendous odds, following up all faulty unions in your pipe line, trying to maintain the appearance of a well regulated plant.

There is no secret about their success. Thousands upon thousands of pleased users are willing to tell you that JEFFERSON UNIONS mean trouble-free service.

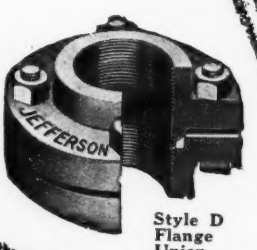
Look into the brass to iron seating surfaces. See how tightly the brass ring is locked in place and so located that the pipe contents can never reach it.

Observe the drop tight ball joint—the two sides brass to iron ground together in pairs which are never again separated.

Last of all note the neat workmanlike appearance of JEFFERSON UNIONS. You will be proud to have them in your lines.

Write us for particulars.

JEFFERSON UNION CO.
LEXINGTON, MASSACHUSETTS
General Sales Offices: 11 W. 42nd St., New York, N. Y.



Style D Flange Union

JEFFERSON UNIONS

THE BIG PROBLEM

Interviews with leading power plant engineers emphasize the fact that the one big problem in feeding modern boilers is the control of differential water pressure. You, too, have probably observed this in your own plant.

COPES engineers anticipated this problem more than eleven years ago. Since 1920, they have been engaged in constant research and development work . . . studying differential pressure control.

New Booklet Now Ready

A new 16-page booklet—Differential Pressure Control—explains the fundamentals. Photographs, charts and diagrams illustrate them. Write for this instructive booklet. A COPES man will show you the application to your big problem.

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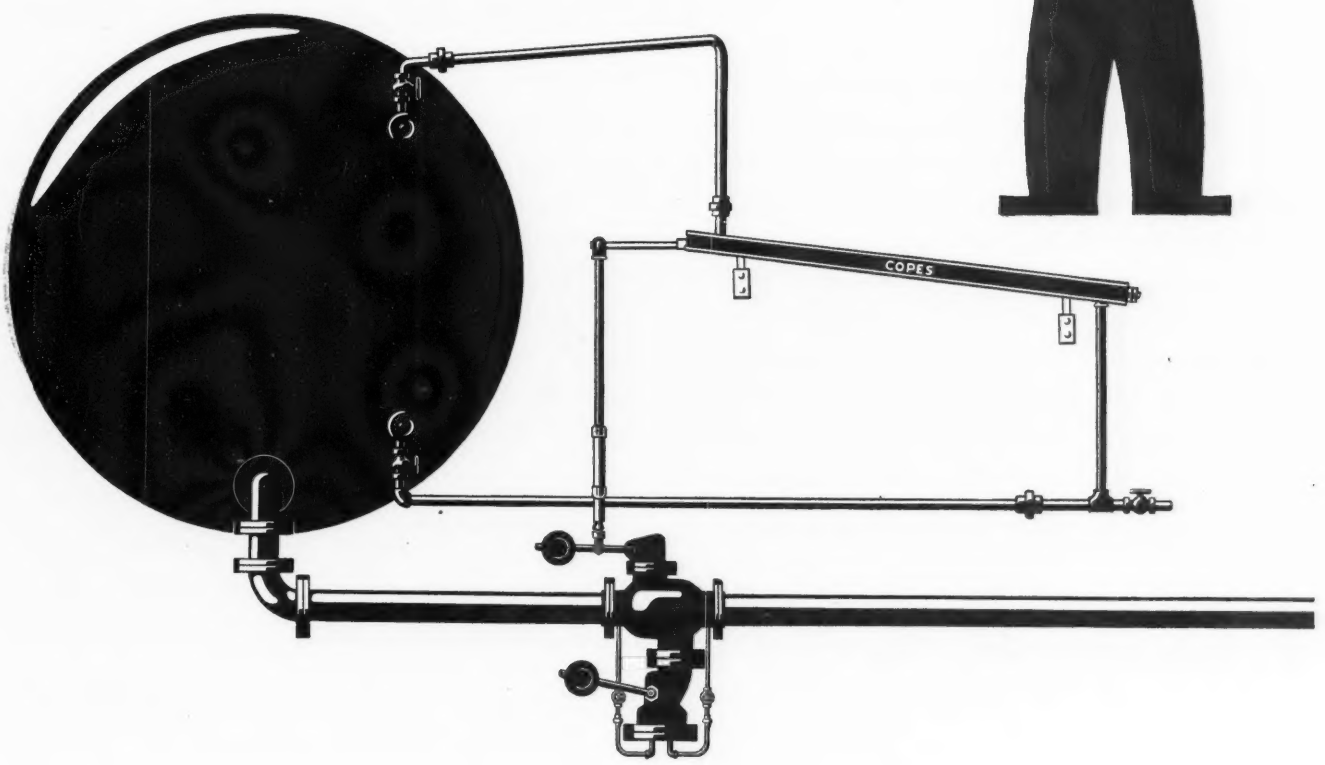
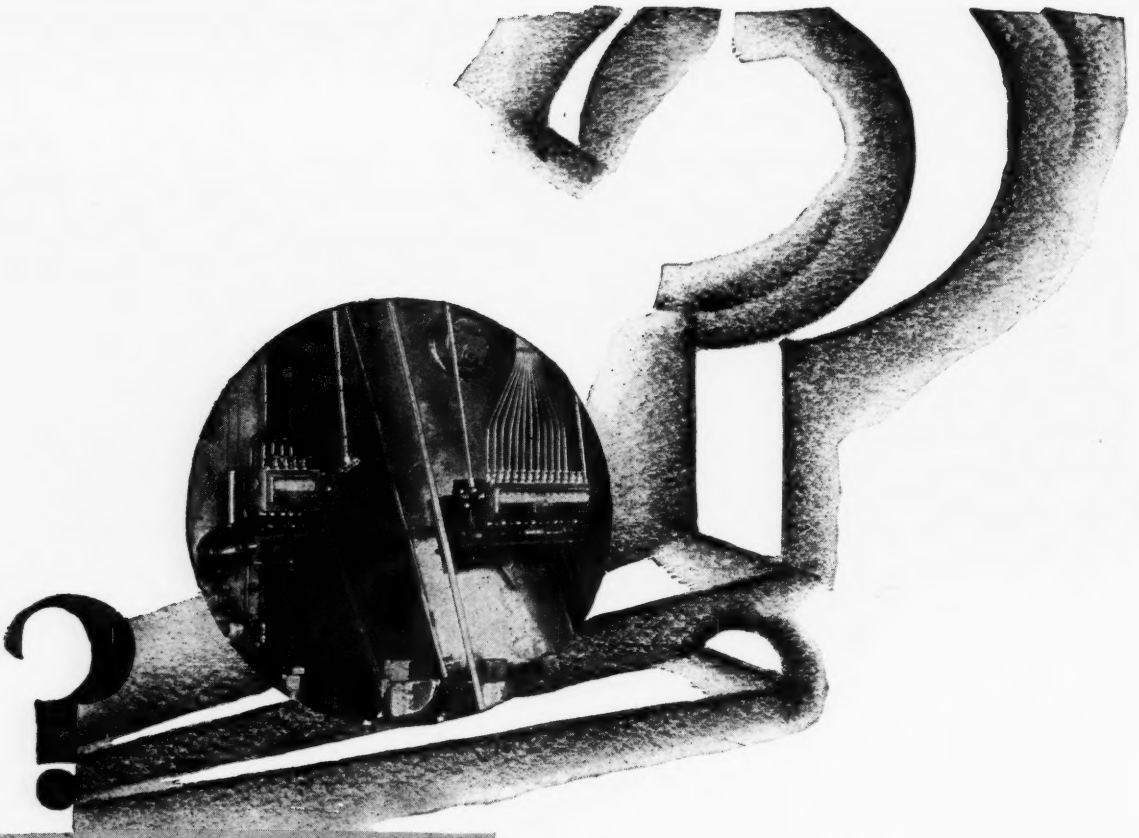
651 Grove Drive, Erie, Pa.
BRANCH PLANTS IN CANADA, ENGLAND, FRANCE, GERMANY, AUSTRIA AND ITALY. REPRESENTATIVES EVERYWHERE.

COPES

SYSTEM OF BOILER FEED CONTROL





too much OIL . . . . too little LUBRICATION

Increased Diesel maintenance costs, power losses and premature shut-down for adjustments and repair are the penalties. Too much oil can never take the place of effective lubrication.

The difference isn't always apparent at once. It takes time for serious troubles to develop, but the effects of too much oil, or too high a carbon content or incorrect viscosity are always far-reaching.

Here's one safe answer. Use only Texaco Ursa Oils of the right grade—in the right amount. These clear, golden oils, in a full viscosity range, are distinguished for low carbon content, freedom from gumming tendencies, excellent lubricating qualities, and uniformity. *There's* an important point. *Every* shipment of Texaco Ursa Oil is the same. There is no guesswork. No need to experiment.

Texaco Lubrication Engineers are always ready to cooperate. They are familiar with the physical qualities of Texaco Ursa Oils and with the operating conditions of every type and size of Diesel. The service is yours without obligation.

TEXACO

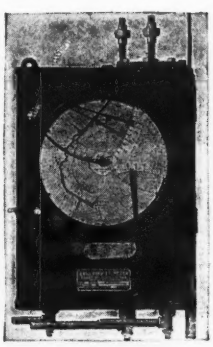
THE TEXAS COMPANY
135 East 42nd Street, New York City

TEXACO LUBRICANTS

Bailey Boiler Meters installed in the boiler room of the New York Life Insurance Building, New York City

CONSIDER THESE ADVANTAGES

Of The Bailey Boiler Meter



BAILEY BOILER METER
Indicates, Records and Integrates Steam Flow, Records Air Flow and Flue Gas Temperature and Indicates Furnace Draft.

1. It serves as a dependable guide to maximum combustion efficiency with a resultant decrease in coal bills.

2. Due to increased boiler efficiency, boiler capacity is increased thereby postponing and sometimes eliminating the necessity of enlarging the boiler plant.

3. One Bailey Boiler Meter fills a threefold need—it serves as a combustion guide, as a steam flow meter and as a temperature recorder. It may indicate, record, and integrate steam flow, record air flow supplied for combustion and record flue gas temperature.

4. All records are made on the one uniformly graduated chart permitting quick and easy analysis.

5. Leaky baffles or dirty tubes are quickly detected by comparison of records.

6. Reliable data are furnished for cost accounting systems.

7. The Bailey Boiler Meter is available in a large number of types and is designed to meet the requirements of the particular installation.

WRITE FOR BULLETIN No. 44

BAILEY METER CO.

1036 IVANHOE ROAD CLEVELAND, OHIO.

Bailey Meter Company Limited, Montreal, Quebec

Have you seen THIS "TALKING" PICTURE?

8" Tube-Turns in air conditioning lines in plant of Multicolor Films, Inc., Los Angeles. H. A. McMurphy, Architect; Tiltz Engineering Co., Engineers; Myers Bros., Contractors.

• The photo above is a "talking picture"—it talks *better piping!*

And it does! The story is built around Tube-Turns, the *seamless* fittings for pipe welding. Notice their freedom from flanges, beads or shoulders—notice how closely they are nested, how easily and uniformly the insulation was applied. . . Look at the offsets—made up *on the job!* Then notice the neat, trim appearance of the entire installation. . . .

Tube-Turns have advantages and combinations of advantages that are available in no other type of fittings. They are *forged* (not bent) by an exclusive process, from *seamless* tubing.

They have uniform walls and therefore greater strength—no stretching or thinning of outside walls, no compressing or thickening of inside walls.

Tube-Turns are made in 45°, 90° and 180° types. Ends beveled 45° for welding.

Available from stock in sizes ¾" to 20" Standard I. P. S. and 1½" to 12" Extra-Heavy I. P. S.

Seamless. Uniform in wall thickness—no thinning of outside walls, no thickening of inside walls, no buckling, no flattening. Stronger. Lighter. Easier to install and insulate. They NEVER leak.

Full pipe-size throughout the turn—no buckling or flattening. Formed on a radius that reduces pressure-loss to the minimum.

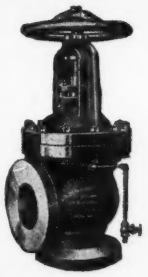
Tube-Turns are made from the same material as the pipe in the line—have the same O. D., the same I. D. and the same wall thickness as the pipe with which they are used. Easier and more economical to install—and with less gas and rod. . . Get *all* the facts about Tube-Turns and the tangible advantages they offer *you.* Ask today for Bulletin 103. No obligation, of course. *Address:* Tube-Turns, *Incorporated,* 1317 South Shelby Street, Louisville, Ky.

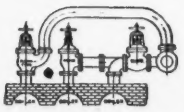
TUBE-TURNS

The Seamless Fittings for Pipe Welding

Safe Continuous Service

GOLDEN-ANDERSON





Angle, Globe or Elbow

Double extra heavy semi steel or cast steel valves for high pressure superheated steam, central station service.

"Perfectly Cushioned"

Patented Automatic *Double Cushioned* Triple-Acting, also Non-Return Valves

1. Automatically cut out the boiler the instant that a tube rupture or other internal break occurs.
2. Automatically cut off the steam flow from every boiler the instant that a steam pipe breaks.
3. Automatically equalize the pressure between all boilers.
4. Automatically cut in a boiler, making accidents due to inaccurate steam gauge impossible.
5. Positively prevent backflow of steam into a cold boiler.
6. Can be closed by hand, like ordinary stop valve, and arranged with "combination feature" to open valve like regular gate and globe valve.
7. Can be tested in service from boiler room floor.
8. Double Corliss Dash Pot that cushions in opening and closing. As they are sealed and out of current steam flow, dirt and grit cannot bind or stick valves.
9. Cannot pound, spin, stick or chatter.
10. By disconnecting pilot valve, the triple-acting style can be changed into plain non-return.

"Heaviest Valves Made"

"2 Valves in One"

"4575" used by the big steel companies

"Perfect Cushioning"

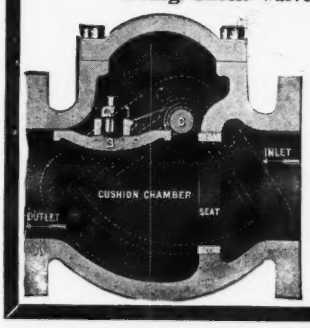
Double Corliss Dash Pots with Enormous Area Insuring Most Positive Cushioning.

Dash Pots Sealed and Cut Off Current of Steam Flow so that Grit or Scale Cannot Bind or Stick Valves.

Most Positive and Dependable Valves Made for Life and Property Protection.

"Hosts of References"
"Every valve with an absolute guarantee."

Pat. Automatic Cushioned Swing Check Valves



1. Especially adapted for water service.
2. For high or low pressure.
3. For vertical horizontal lines.
4. Ideal Bleeder Valve.
5. Sizes to 24 in.

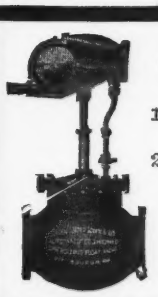
Pat. Automatic Cushioned Water Float Valves

1. Automatically maintain uniform water levels in tanks, standpipes, etc.

2. Instantly adjusted to operate quickly or slowly.
3. Floats swivel to any angle—Most satisfactory float valves known.
4. No metal-to-metal seats — No water hammer or shock.

Sizes ½ in. to 24 in.

5. Cushioned by water and air.

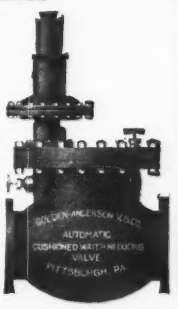


Pat. Automatic Cushioned Controlling Float Valve

1. Automatically maintains uniform level in heaters, tanks, etc.
2. Air and water cushioned.
3. No metal-to-metal seats.
4. No waste of water.
5. No water hammer or shock.
6. Angle or Globe patterns to 24 in.

Pat. Automatic Cushioned Water Pressure Regulating Valves

1. Maintain a constant reduced pressure regardless of fluctuations on high pressure side.
2. Perfectly cushioned by water and air. No metal-to-metal seats.
3. The best valve made for maintaining a constant low pressure where consumption is continuous.
4. Operates quickly or slowly as required—No attention necessary.
5. Positively no hammering or sticking. Sizes to 24 in.

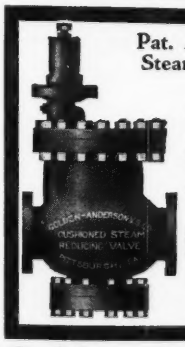


Now Our Water System Will Never Be Interrupted

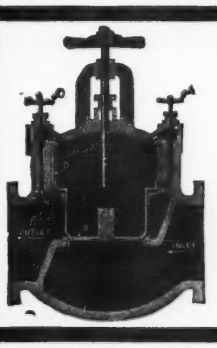
Thanks to Our Pat. Cushioned Automatic Controlling Altitude Valves

1. Automatically maintain uniform water levels in tanks, standpipes, reservoirs, etc.
2. For high or low pressure. Always dependable.
3. No floats or fixtures used.
4. No water hammer or shocks.
5. Sizes up to 24 in.

Pat. Automatic Cushioned Steam Pressure Reducing Valves



1. Maintain a constant reduced pressure.
2. Thoroughly cushioned.
3. No hammering, chattering or sticking.
4. No auxiliary valves or small by-passes to clog up.
5. No wire drawing.
6. Only one adjustment from the outside.
7. Double extra heavy throughout — practically indestructible.

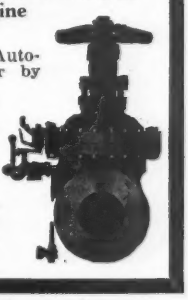


Pat. Automatic Cushioned Check and Hand Stop Valve

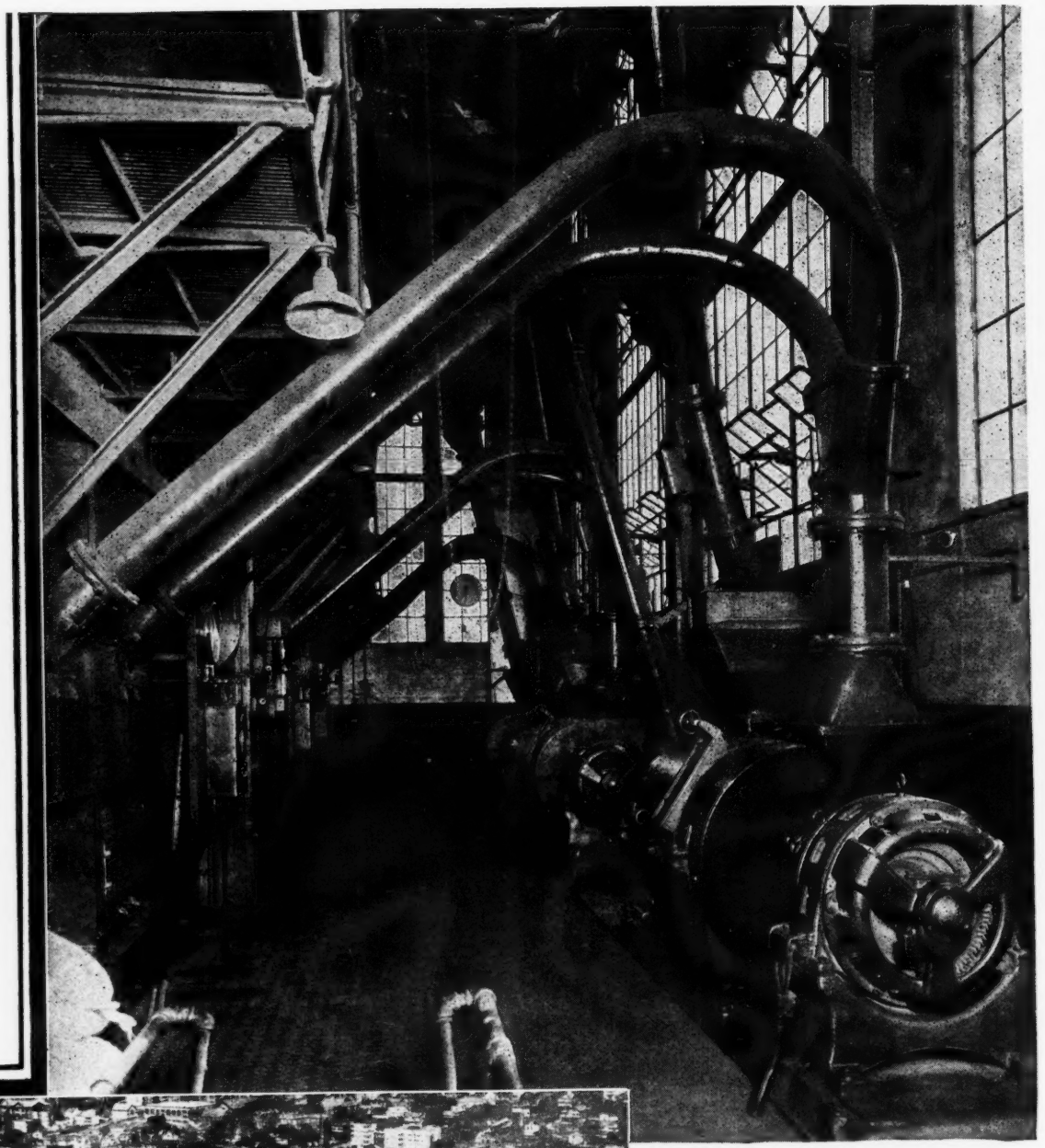
1. Adapted for water service and boiler feed lines.
2. Always cushioned in opening and closing.
3. Quickly regulated for fast or slow closure.
4. No water hammer or shock any time.
5. Sizes 3-in. to 24-in. inclusive.

Pat. Cushioned Combined Throttle and Automatic Engine Stop Valves

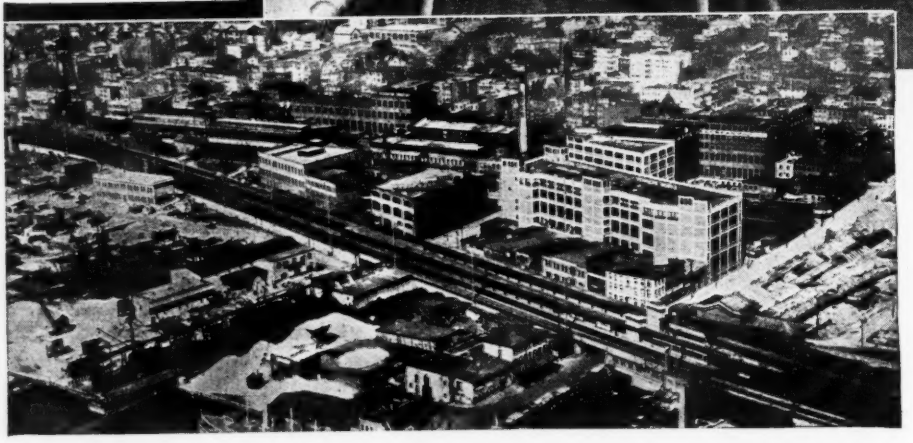
1. Operate 3 ways: Automatically, by Hand, or by Electric Switch.
2. Prevent Fly-wheel Explosions.
3. "Double Corliss" Cushioned—No Pounding or Sticking.
4. Contain No Tight Fitting Parts.
5. Furnished in Angle and Globe Patterns for High or Low Pressures.
6. "Always Ready for Service."



Golden-Anderson Valve Specialty Co., 1317 Fulton Bldg., Pittsburgh, Pa.



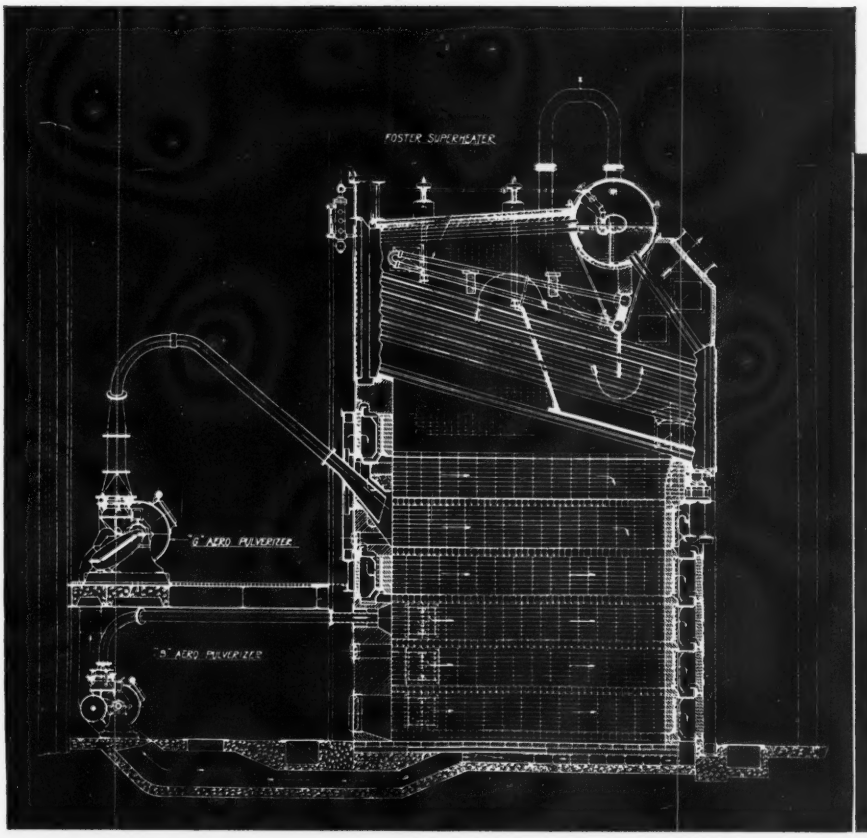
Firing aisle in the rebuilt power plant of the Otis Elevator Company, Yonkers, N. Y. Three Aero unit pulverizers are shown, each of which fires a 604 hp. boiler through two burners placed in the front wall of the furnace. Each pulverizer is equipped with automatically controlled feed mechanism so that minimum labor is required.



Aerial view of the Yonkers Works of the Otis Elevator Company, which has been advancing the science of vertical transportation since 1852. Three Foster Wheeler equipped steam generators are installed in the modern power station of this plant.

AIR PREHEATERS CONDENSERS
ECONOMIZERS CENTRIFUGAL PUMPS
COOLING TOWERS EVAPORATORS
EXPANSION JOINTS VACUUM PUMPS
FEED WATER HEATERS SUPERHEATERS
BRASS AND COPPER TUBING AND PIPE

FOSTER



Arrangement of steam generating units in the Yonkers Power Plant of the Otis Elevator Company. The 6040 sq.ft. boilers are pulverized fuel fired by the Foster Wheeler unit system and are equipped with Foster Wheeler superheaters to add 158 deg. F. superheat to the steam generated at a pressure of 250 lb. per sq. in. A small auxiliary pulverizer, located on the lower floor of the boiler room, economically provides light load service.

Reduced Industrial Power Costs

To reduce the cost of steam generation and meet increasing power requirements, three modern steam generators replaced ten boilers at the Yonkers Plant of the Otis Elevator Company. The rebuilt power station is a good example of improvements possible by taking advantage of modern devices in power generation.

The steam generating equipment includes 604 hp. boilers equipped with Foster Wheeler convection type superheaters and Foster Wheeler system of firing pulverized fuel. The furnace walls and floor are air cooled, the preheated air being used for mill drying of fuel in the Aero pulverizers.

The steam generators economically meet wide fluctuations in load. They also provide reduced power for week-end and holiday periods at highly efficient operation.

FOSTER WHEELER CORPORATION

165 Broadway, New York, N. Y.

Foreign Associates—
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Societe Anonyme Foster Wheeler: Paris, France
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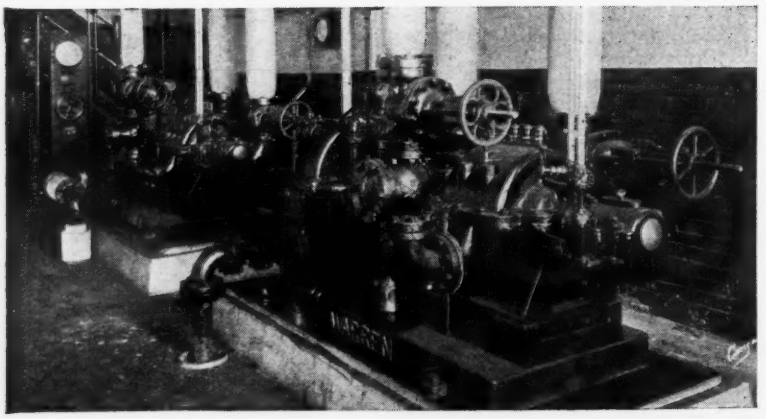
GASOLINE RECOVERY SYSTEMS
HEAT EXCHANGE EQUIPMENT
OIL REFINING EQUIPMENT
WASTE HEAT BOILERS
WATER COOLED FURNACES
PULVERIZED FUEL SYSTEMS



Two Warren boiler feed pumps (turbine driven) in the new power plant of M. J. Whittall Associates Ltd., makers of the famous Anglo - Persian rugs.

Warren provides three "extras" with every pump . . .

Warren pumps will meet the requirements of specifications established by you—and provide three "extras" in addition:

1. Liberal clearances (.015 to .025 inches) protect the case rings from unnecessary wear. Warren pumps *maintain their original efficiencies over a long period of time.*
2. Built to precision standards from materials of the highest quality, Warren pumps stay on the job 24 hours a day, week in and week out. Plant records show *unusually low maintenance charges.*
3. Centrifugal pump design of two years ago is out of date. Close contact with power plant problems, plus constant research and development work, have kept Warren pump design abreast of the improvements in power plant engineering, resulting in consistently *low operating costs.*

Three "extras"—sustained high efficiencies, low maintenance and low operating costs—are included in every Warren quotation. If you want the lowest possible pumping cost per year, get in touch with Warren.

Warren

Steam Pump Company Inc.

WARREN

Warren Massachusetts

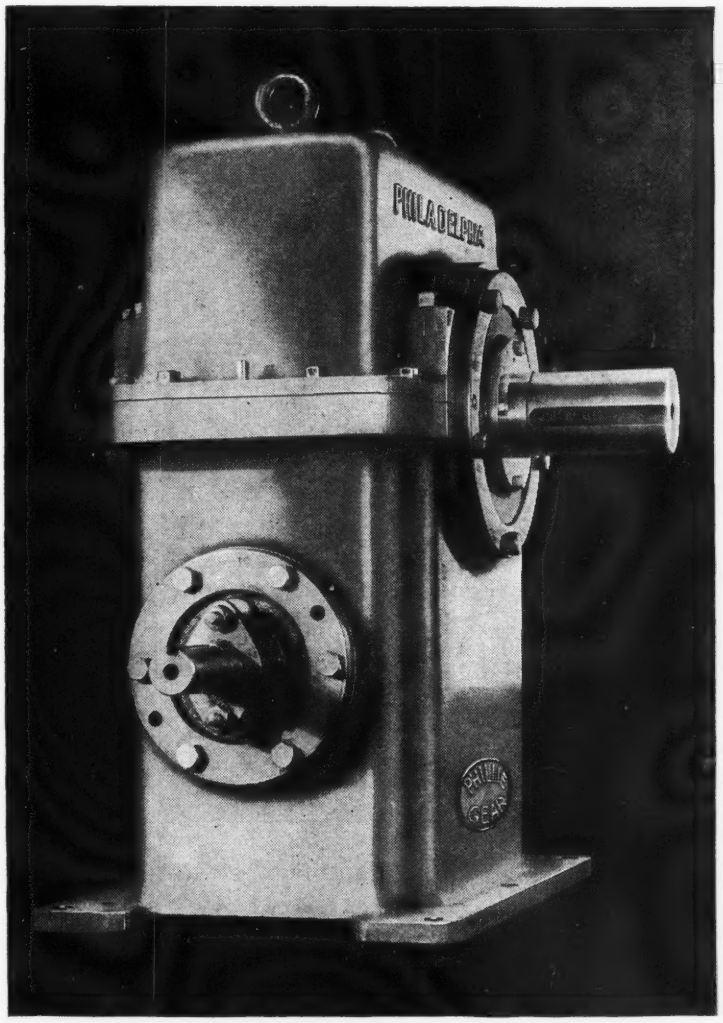
AGENCIES IN ALL PRINCIPAL CITIES

4853

"PHILADELPHIA" *Offers Indestructible*

STEEL SPEED REDUCER HOUSINGS

as Standard Equipment



THE famous line of Philadelphia Speed Reducer Units are now available in rolled STEEL Casings, 75% to 100% stronger.

Built to last a lifetime, with every inch and ounce of this most durable metal contributing extra strength—accidents can't happen to these Speed Reducers. In Steel Mills or in other strenuous service where a dropped ingot, a swinging beam or contact with other heavy objects would normally crush a cast iron Reducer Casing—these indestructible Steel Housings protect the fine mechanisms they contain from violence. In effect, they are hermetically sealed vaults, armored against accident. All the smooth-running, quiet, powerful efficiency is sealed in—dust, dirt, moisture, acid fumes and other external dangers are sealed out.

The indestructible Steel Housing is the final, unqualified assurance that Philadelphia Speed Reducers will serve you better, longer and more economically than any other reducers offered to industry, today.

Send the coupon for the Philadelphia Speed Reducer Book—a modern treatise on industrial drives for all speed ratios and drive conditions. Do it today.

Philadelphia
SPEED REDUCING UNITS
ONE NAME • ALL TYPES

PHILADELPHIA POWER SAVING PRODUCTS

Gears—Spur, Worm, Herringbone, Internal, Bevel, Miter, Intermittent, Spiral, Helical, Continuous Tooth Herringbone and Spiral Bevel Gears. —***Non-Metallic Pinions***—Fabroil, Textolite, Rawhide.—***Speed Reducer Units***—All types, all ratios, for all drive conditions.—***V-Belt Drives***—A complete line. ***Miscellaneous***—Whitney Silent and Roller Chains, Sprockets, Flexible Couplings, Universal Joints, Racks, Ratchets and Pawls.

THIS COUPON IS VALUABLE

It entitles you to a copy of the newly issued 120-page Speed Reducer Book—free of charge or obligation.

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Company .....

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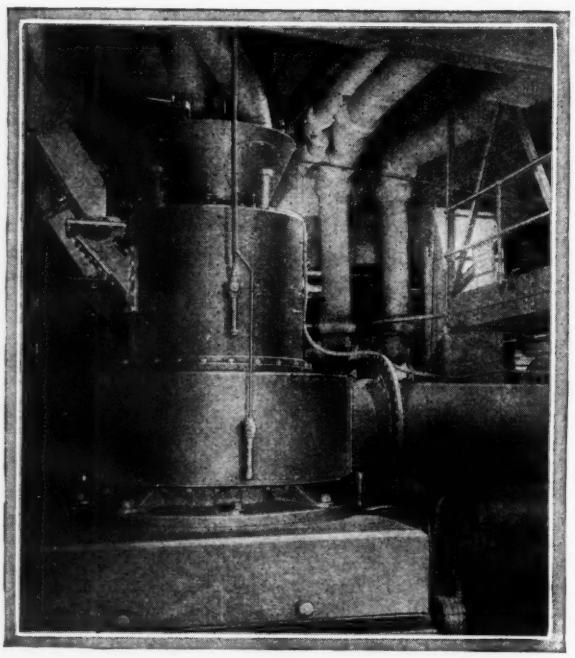
PHILADELPHIA GEAR WORKS

WORLD'S LARGEST DIRECT FI
TYPE B PULVERIZERS *and* BA

HELL GATE RELIES ON FULLER LEHIGH EQUIPMENT FOR TWO BOILERS RECENTLY PLACED IN OPERATION



One of the four Fuller Lehigh Type B Pulverizers that serve each boiler. Removal of the finely pulverized coal from the mills is effected by air under pressure.

WHEN large metropolitan stations, such as Hell Gate Station of the United Electric Light & Power Company, install the Fuller Lehigh direct-fired system of pulverized-coal firing there are good reasons for the selection. Units of high capacity and of unquestioned reliability must be installed in order to achieve the utmost efficiency in the use of the building site.

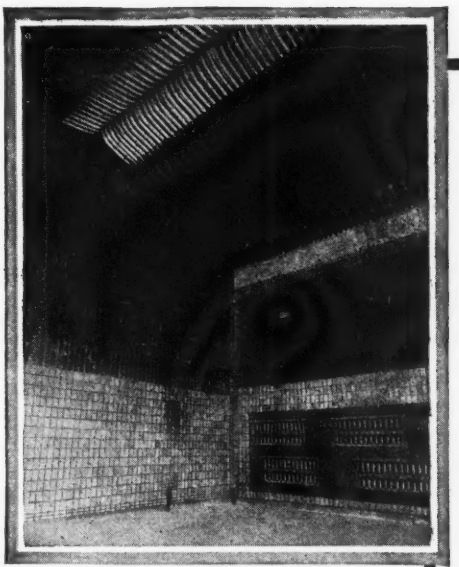
Fuller Lehigh Equipment — including Type B Pulverizers, Bailey Water-Cooled Furnaces of the slag-tap type, and Cross-Tube Burners—is serving two twin Babcock & Wilcox Cross-Drum Boilers recently placed in operation at the Hell Gate Station.

The Type B Pulverizers contribute much to the reliability and ease of control of these high-capacity direct-fired boilers. The pulverizers operate at constant speed and require few adjustments to change a boiler's output. Moreover, sustained high capacity and fineness with economy in power consumption are other outstanding features of the mills.

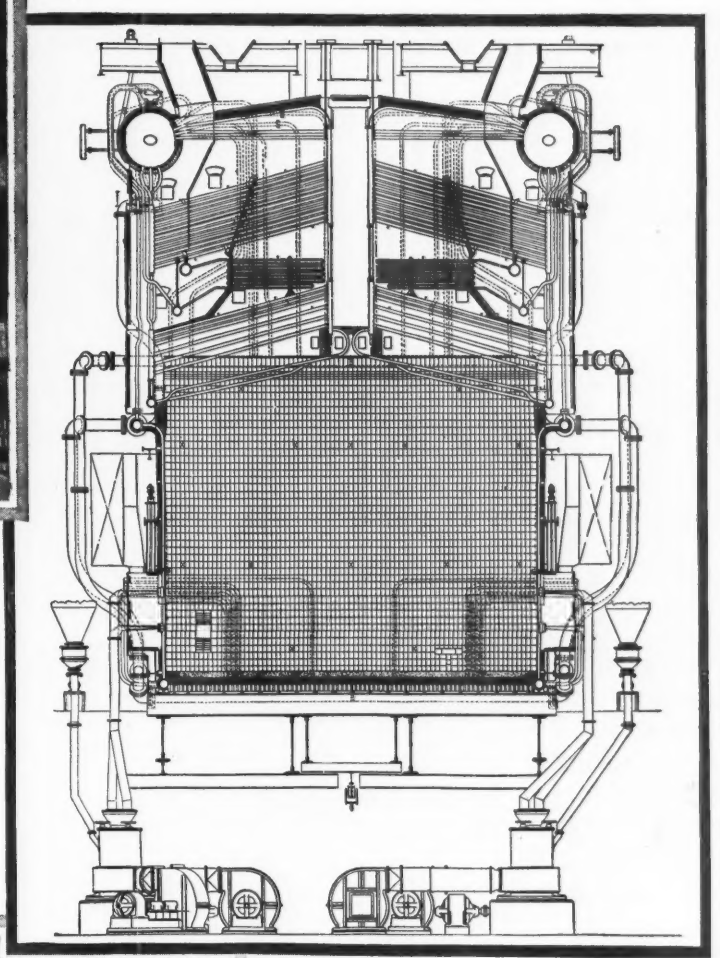
The Bailey Water-Cooled Construction assures reliability and low maintenance of the furnaces; while the slag-tap method is a clean and effective means for removing the ash.

FULLER LEHIGH COMPANY
A Babcock & Wilcox Organization
85 LIBERTY ST., NEW YORK, N.Y.

FIRED BOILERS *are served by* BAILEY SLAG-TAP FURNACES

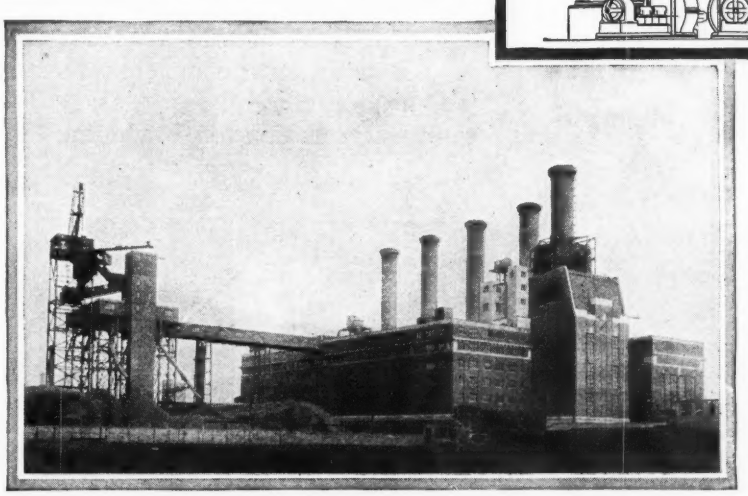


Interior of one of the Bailey Slag-Tap Furnaces at the Hell Gate Station showing four of the Fuller Lehigh Cross-Tube Burners. Each furnace has a volume of 45,100 cu. ft. and a water-cooled wall area of 4590 sq. ft.



Arrangement of one of the two largest direct-fired boiler units ever built. They are in service at the Hell Gate Station of the United Electric Light & Power Company, New York, N. Y. The boilers each have 52,732 sq. ft. total heating surface and generate over 1,000,000 lb. of steam per hour. Each boiler is equipped with a Bailey Slag-Tap Furnace fired with pulverized coal through twelve Fuller Lehigh Cross-Tube Burners—supplied by four Type B Pulverizers.

The Hell Gate Station of the United Electric Light & Power Company.

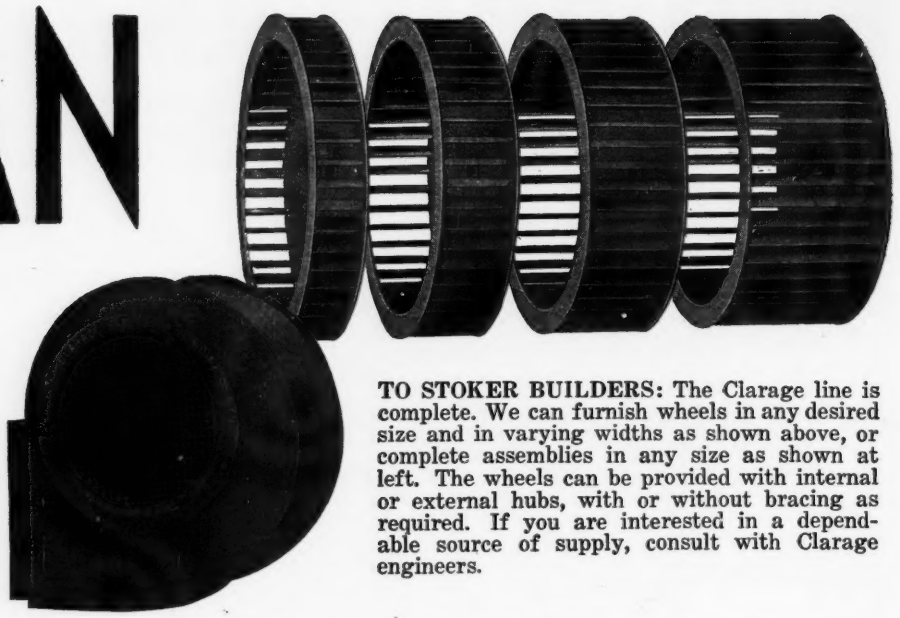


FULLER LEHIGH

PULVERIZED-COAL EQUIPMENT ~ WATER-COOLED FURNACE WALLS

2261

The FAN — A VERY IMPORTANT PART OF YOUR UNIT STOKER INSTALLATION



TO STOKER BUILDERS: The Clarage line is complete. We can furnish wheels in any desired size and in varying widths as shown above, or complete assemblies in any size as shown at left. The wheels can be provided with internal or external hubs, with or without bracing as required. If you are interested in a dependable source of supply, consult with Clarage engineers.

WHETHER it's a power boiler installation or a domestic heating job, it pays to select your unit stoker fan with care.

This fan must deliver exactly the right volume of air at the right pressure, if you are to effect maximum fuel economy; and it must be a strong, rigid, perfectly balanced unit, if you are to enjoy trouble-free operation year after year. Back of Clarage Fans is almost a quarter century of specialized experience in the combustion field. We have a thorough knowledge of unit stoker requirements, and we have the equipment to meet those requirements.

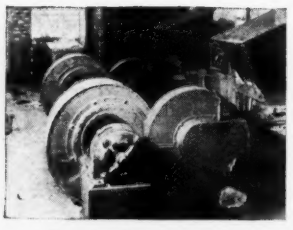
Clarage Unit Stoker Fans perform as specified—no guessing. They are built by modern and improved methods which combine light weight with the utmost in strength and rigidity. And last, but of prime importance, they are perfectly balanced both statically and dynamically on Tinius Olsen Balancing Machines, eliminating vibration and excessive wear on wheel, shaft and bearings, and producing quiet, smooth-running units of extremely long life.

A high percentage of the leading unit stoker builders recommends Clarage Fans and uses them as standard equipment.

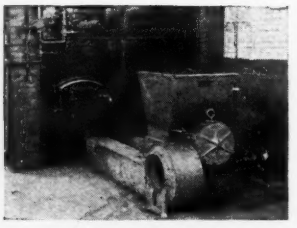
WRITE FOR ILLUSTRATED BULLETIN NUMBER 541-A

Write for Illustrated Bulletin 541-A and learn all of the reasons why. This Bulletin gives complete information and performance data. Clarage Fan Company, Kalamazoo, Michigan.

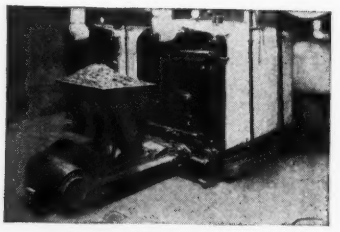
Clarage Fan and Fire-King Unit Stoker.



Clarage Fans and two Jones Stoker Units.



Clarage Fan and Brownell Unit Stoker.



Clarage Fan and Detroit Junior Stoker.

CLARAGE UNIT STOKER FANS

The RILEY-
-BADENHAUSEN
STEAM GENERATING UNIT

Outstanding among the country's leading steam producing equipment

RILEY ATRITA UNIT PULVERIZERS
RILEY FLARE TYPE BURNERS
RILEY UNDERFEED STOKERS
HARRINGTON TRAVELING GRATE STOKERS
JONES SIDE-DUMP STOKERS

BADENHAUSEN WATER TUBE BOILERS
BADENHAUSEN SUPERHEATERS
BADENHAUSEN ECONOMIZERS
BADENHAUSEN AIR PREHEATERS
BADENHAUSEN WATER COOLED FURNACES
BADENHAUSEN STEEL-CLAD, INSULATED SETTINGS

one contract . . . .

one responsibility!

RILEY STOKER CORPORATION
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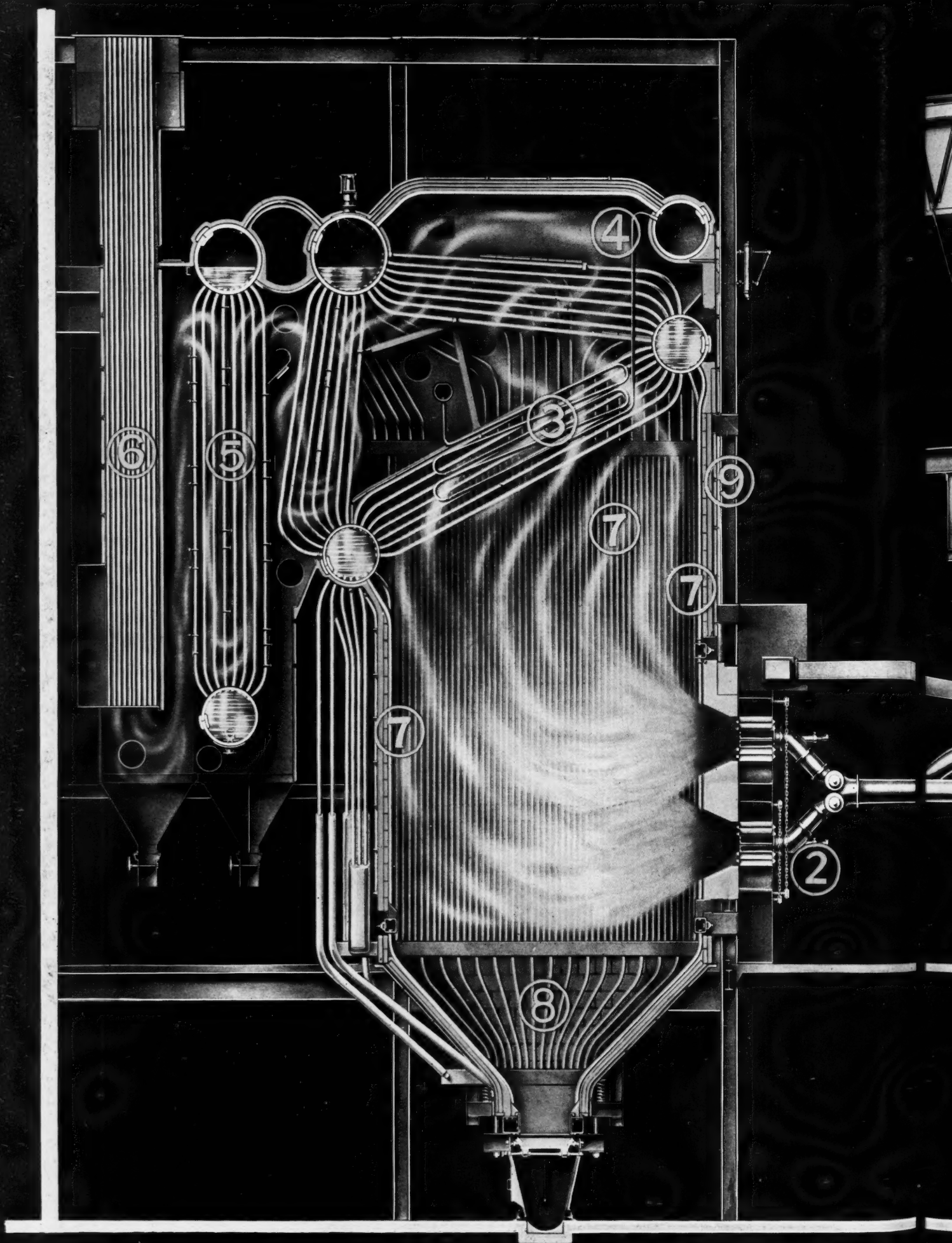
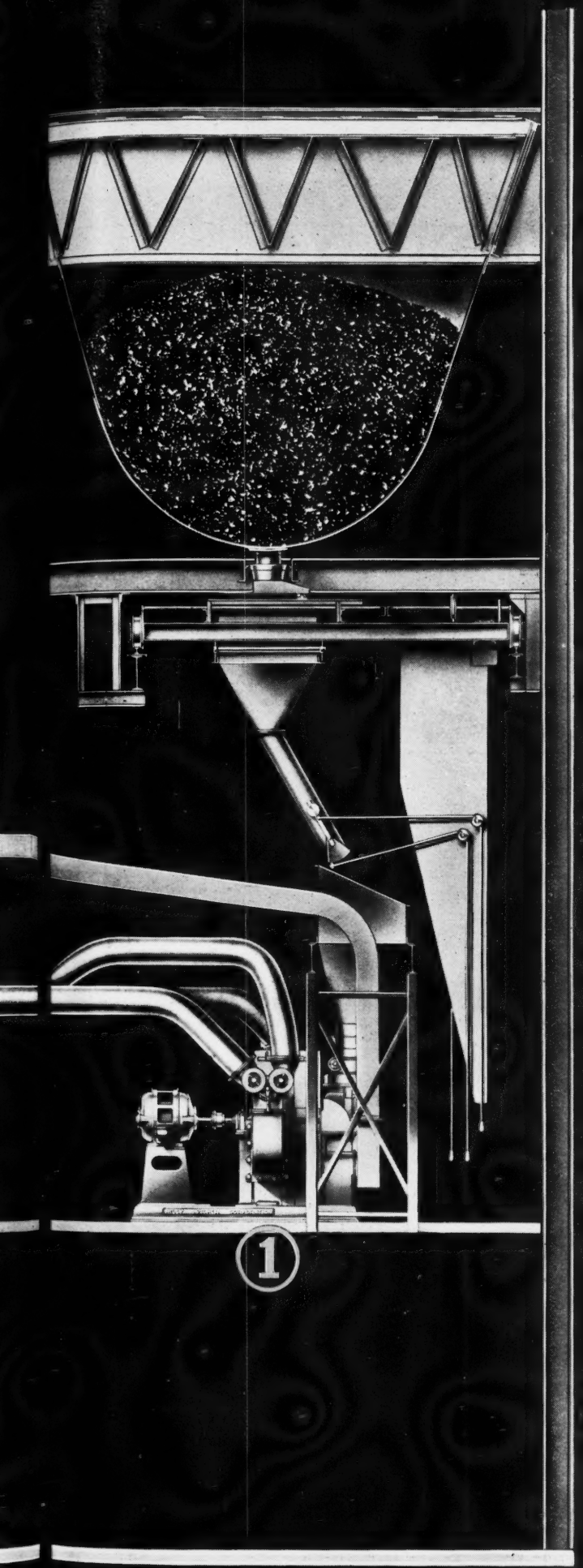
Andersen-Meyer & Co., China — International Machinery Co., (W. R. Grace Co.,) South America
American Trading Co., Japan — Fama—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia



THE RILEY-BADENHAUSEN

*1 RILEY ATRITA UNIT PULVERIZER
2 RILEY FLARE TYPE BURNER
3 BADENHAUSEN WATER TUBE BOILER
4 BADENHAUSEN SUPERHEATER
5 BADENHAUSEN ECONOMIZER
6 BADENHAUSEN AIR PREHEATER



A Few Outstanding Installations

RILEY-BADENHAUSEN STEAM GENERATING UNITS

and results being obtained with them

SUNBURY CONVERTING WORKS, BELVIDERE, N. J.

Two complete units, 350 lbs. pressure—3 No. 5 Riley Pulverizers, Badenhausen Boilers, Water Preheaters, Air Heaters, Water Cooled Furnaces, Steel Clad Furnace Setting. Efficiency 88.24%. Maximum rating 161,000 lbs. of steam per hour.

ABERFOYLE MANUFACTURING CO., CHESTER, PA.

Two units, 300 lbs. pressure—3 No. 4 Riley Pulverizers, Badenhausen Boilers, Water Preheaters, Air Heaters, Water Cooled Furnaces. Test efficiency 90.3%. Efficiency over 30-day period 87.0%. Maximum rating 135,000 lbs. of steam per hour. Minimum 13,800 lbs. of steam per hour.

ATWATER KENT MFG. CO., PHILADELPHIA, PA.

Three complete units, 200 lbs. pressure—3 No. 5 Riley Pulverizers, Badenhausen Boilers, Superheaters, Air Heaters, Water Cooled Furnaces, Steel Clad Furnace Settings. Efficiency 86.64%. Capacity up to 82,000 lbs. of steam per hour.

PHILIP CAREY MANUFACTURING CO., PLYMOUTH MEETING, PA.

Two complete units, 350 lbs. pressure—3 No. 4 Riley Pulverizers, Badenhausen Boilers, Water Preheaters, Air Heaters, Water Cooled Furnace, Steel Clad Furnace Setting. Maximum capacity 130,000 lbs. of steam per hour—87% efficiency at 400% of rating.

FRANKLIN HEATING STATION, ROCHESTER, MINN.

Serving properties of Mayo Clinic and Kahler Corporation. One unit, 250 lbs. pressure—2 No. 4 Riley Pulverizers, Badenhausen Boiler, Air Heater, Water Cooled Walls, Steel Clad Furnace. Maximum operation 80,000 lbs. of steam per hour. Monthly efficiency 84.85%.

RESTIGOUCHE COMPANY, LTD., ATHOL, NEW BRUNSWICK, CANADA

Two complete units, 350 lbs. pressure—3 No. 5 Riley Pulverizers, Badenhausen Boilers, Water Preheaters, Air Heaters, Superheaters, Water Cooled Furnaces, Steel Clad Furnace Settings.

HARNISCHFEGER CORPORATION, MILWAUKEE, WIS.

Two units, 180 lbs. pressure—2 four retort Riley Stokers. Badenhausen Boilers, Air Heaters, Water Cooled Furnace. Maximum output 40,000 lbs. of steam per hour—efficiency 84.29%.

OTTER TAIL POWER CO., WASHBURN, N. D.

Three units, 260 lbs. pressure—3 Harrington Stokers, Badenhausen Boilers and Air Preheaters. Maximum capacity 400% of rating when burning 6300 B.T.U. lignite containing as high as 37% moisture.

THE LEHIGH VALLEY COAL CO., WILKES-BARRE, PA.

Three units, 200 lbs. pressure—3 Harrington Stokers, 3—704 H.P. Badenhausen Boilers and Economizers. Maximum capacity 300% of rating when burning No. 3 Buckwheat anthracite. No. 4 Buckwheat and silt are also burned at this installation.

You are cordially invited to investigate performance of the above installations of Riley Fuel Burning and Badenhausen Steam Generating Equipment. An investigation will conclusively show you reasons why this equipment is so satisfactory to install and operate.

RILEY STOKER CORPORATION
WORCESTER, MASS., U. S. A.

BOSTON NEW YORK PHILADELPHIA PITTSBURGH BUFFALO CLEVELAND DETROIT TACOMA ST. LOUIS CINCINNATI CHICAGO ST. PAUL KANSAS CITY DENVER CHARLOTTE EL PASO SALT LAKE CITY NEW ORLEANS

RILEY ENGINEERING AND SUPPLY CO., LTD., TORONTO

Riley Stoker Co., Ltd., London — Feuerungsanlagen Aktiengesellschaft, Germany
Anderson-Meyer & Co., China — International Machinery Co., W. R. Grace Co., South America
American Trading Co., Japan — Fasma—France, Italy, Holland, Belgium, Switzerland, Jugo-Slavia

STEAM GENERATING UNIT

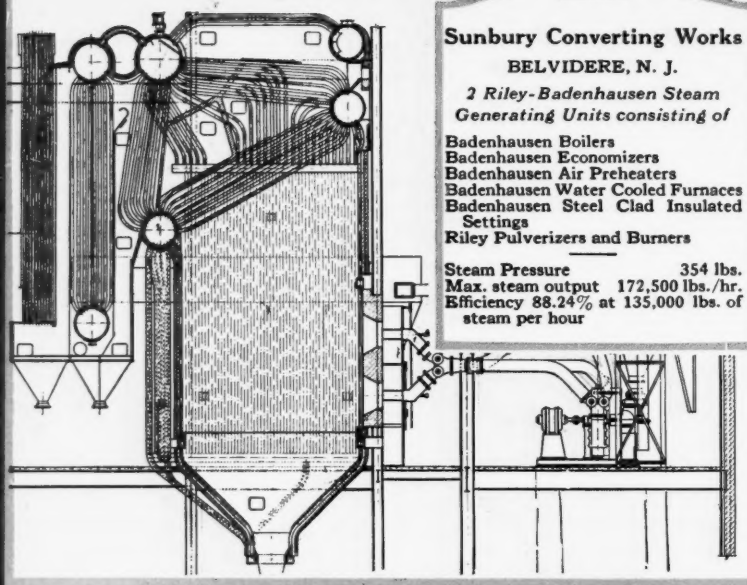
7 BADENHAUSEN WATER-COOLED WALLS
8 BADENHAUSEN WATER-COOLED HOPPER BOTTOM
9 BADENHAUSEN STEEL CLAD SETTING

*When desirable, the following fuel burning equipment may be substituted for Riley Pulverizers:

RILEY UNDERFEED — JONES SIDE-DUMP
OR HARRINGTON TRAVELING GRATE STOKERS

3 BADENHAUSEN WATER TUBE BOILER 3 BADENHAUSEN AIR PREHEATERS

A FEW TYPICAL INSTALLATIONS OF RILEY-BADENHAUSEN STEAM GENERATING UNITS

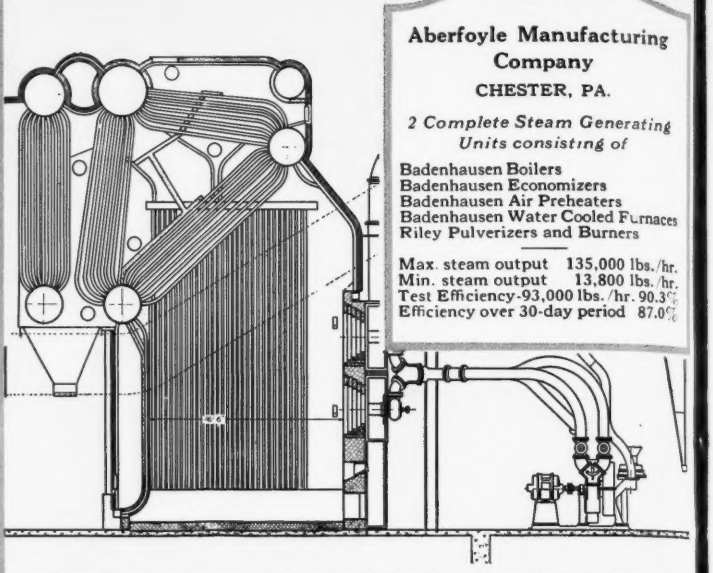


Sunbury Converting Works
BELVIDERE, N. J.

2 Riley-Badenhausen Steam Generating Units consisting of

Badenhausen Boilers
Badenhausen Economizers
Badenhausen Air Preheaters
Badenhausen Water Cooled Furnaces
Badenhausen Steel Clad Insulated Settings
Riley Pulverizers and Burners

Steam Pressure 354 lbs.
Max. steam output 172,500 lbs./hr.
Efficiency 88.24% at 135,000 lbs. of steam per hour

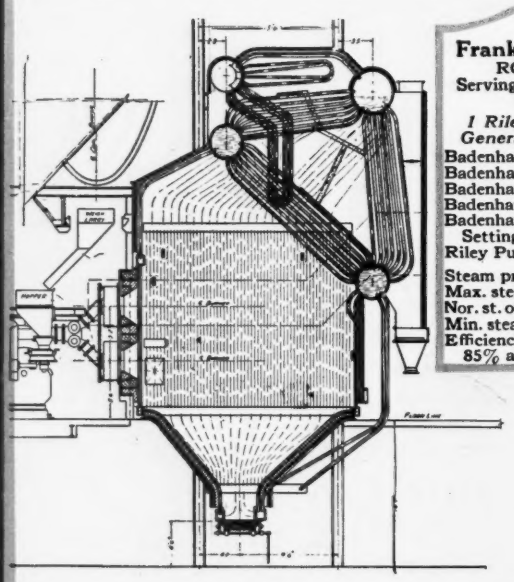


Aberfoyle Manufacturing Company
CHESTER, PA.

2 Complete Steam Generating Units consisting of

Badenhausen Boilers
Badenhausen Economizers
Badenhausen Air Preheaters
Badenhausen Water Cooled Furnaces
Riley Pulverizers and Burners

Max. steam output 135,000 lbs./hr.
Min. steam output 13,800 lbs./hr.
Test Efficiency-93,000 lbs./hr. 90.3%
Efficiency over 30-day period 87.0%

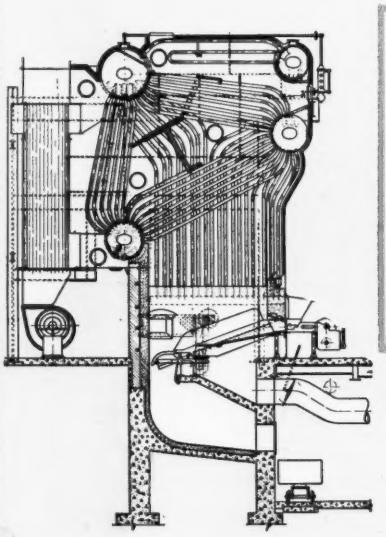


Franklin Heating Station
ROCHESTER, MINN.
Serving properties of Mayo Clinic and Kahler Corp.

1 Riley-Badenhausen Steam Generating Unit consisting of

Badenhausen Boilers
Badenhausen Superheater
Badenhausen Air Preheater
Badenhausen Water Cooled Furnace
Badenhausen Steel Clad Insulated Setting
Riley Pulverizers and Burners

Steam pressure 311 lbs.
Max. steam output 80,000 lbs./hr.
Nor. st. output, 50,000-70,000 lbs./hr.
Min. steam output 10,000 lbs./hr.
Efficiencies range between 84 and 85% at normal load.

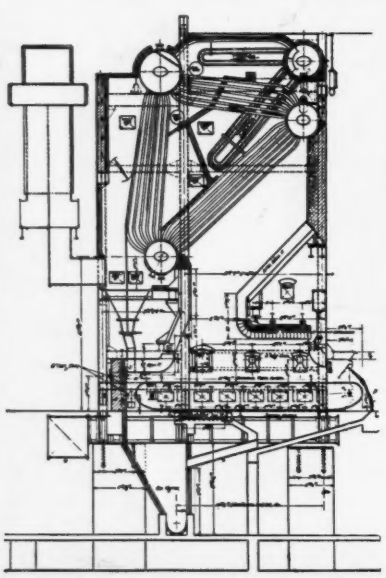


Harnischfeger Corporation
MILWAUKEE, WISC.

2 Steam Generating Units consisting of

Badenhausen Boilers
Badenhausen Superheaters
Badenhausen Air Preheaters
Badenhausen Water Cooled Furnace
Riley Underfeed Stokers

Max steam output 40,000 lbs./hr.
Efficiency—84.29% at 25,252 lbs. of steam per hour.

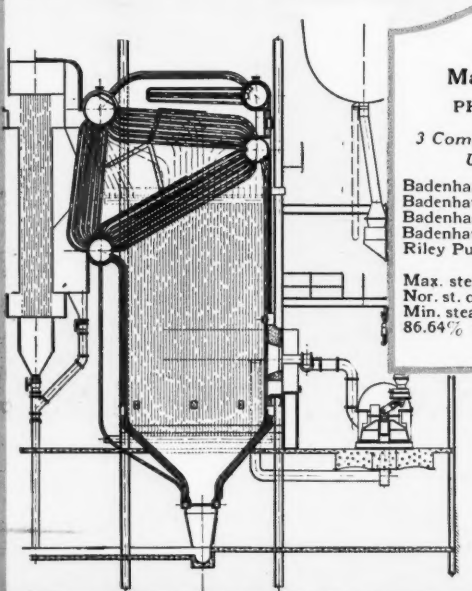


Otter Tail Power Co.
WASHBURN, N. DAK.

3 Steam Generating Units consisting of

Badenhausen Boilers
Badenhausen Air Preheaters
Badenhausen Superheaters
Harrington Traveling Grate Stokers

Max. capacity 69,000 lbs. of steam per hour, 400% of rating, when burning lignite of 6300 B. T. U. and 37% moisture.



Atwater Kent Manufacturing Co.
PHILADELPHIA, PA.

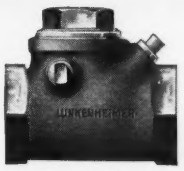
3 Complete Steam Generating Units consisting of

Badenhausen Boilers
Badenhausen Air Preheaters
Badenhausen Superheaters
Badenhausen Water Cooled Furnace
Riley Pulverizers and Burners

Max. steam output 82,000 lbs./hr.
Nor. st. output 45 to 62,000 lbs./hr.
Min. steam output 26,000 lbs./hr.
86.64% efficiency at 63,610 lbs. of steam per hour

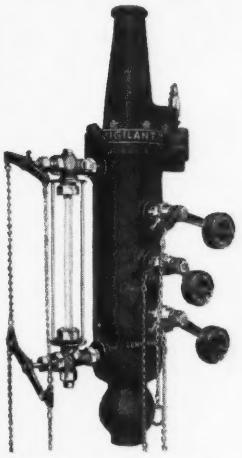
LUNKENHEIMER

Boiler Mountings

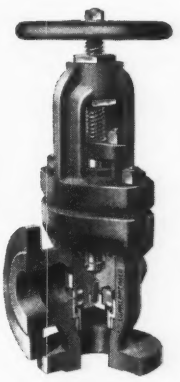


Regrinding
Swing Check Valve

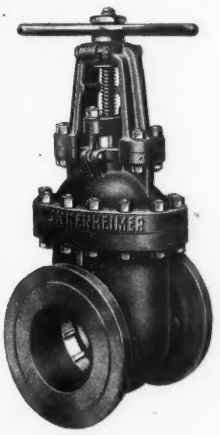
Enclosed Spring
Pop Safety Valve



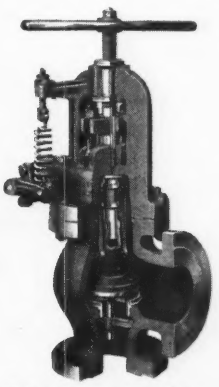
"Vigilant" Safety Water
Column equipped with
Extra Heavy Water Gauge
and "Renewo" Gauge Cocks



"Duro"
Blow-off Valve



Gate Valve



Safety Non-return Valve

Buy from the local
Lunkenheimer Distributor

THE LUNKENHEIMER CO.
"QUALITY"
CINCINNATI, OHIO, U. S. A.
NEW YORK · CHICAGO · BOSTON · PHILADELPHIA
PITTSBURGH · SAN FRANCISCO · LONDON
EXPORT DEPT. 318-322 HUDSON ST., NEW YORK

36-27-42

5,500 ft.

of pipe hung in tunnels with—

HEAT

GRINNELL

Grinnell Adjustable Pipe Hangers and Grinnell Saddles to protect its insulation. ***See photo No. 2.***

For the high pressure piping in the power plant...for the tunnel piping to all ward buildings and cottages...for all the piping in these buildings—standard Grinnell Pipe Hangers and Supports, all capable of adjustment after erection, were used. Many Thousands.

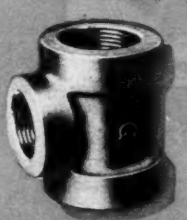
Imagine the economy of installation.
Imagine the low maintenance.
Imagine the pride **of L. A. Snider Engineering Service, Inc., which handles the mechanical work of this character for the State of Illinois.**

Photograph No. 1 shows U.F.S. (Universal Forged Steel) I-Beam Clamp Hangers. No. 3 shows Grinnell Adjustable Pipe Supports and Steel Brackets. Miles of smaller piping is hung with adjustable hangers of various types; quickly adjustable for pitch and straightness of lines. The contractors, Klein and Heckman Company, can testify that the Grinnell line of hangers, brackets, and supports meets every conceivable construction need.

ALL THESE GRINNELL PRODUCTS

HANGERS

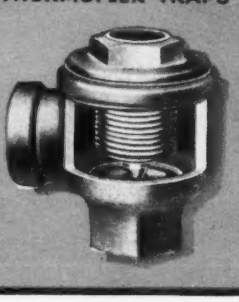
FITTINGS



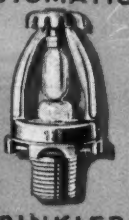
Pipe fittings, cast and malleable, perfectly threaded, accurately machined and rigidly inspected. Pipe hangers adjustable after the pipe is up. Reduce installation costs and maintenance expense.

This trap, with the famous Hydron Bellows, will operate a radiator for a lifetime without repairs.

THERMOFLEX TRAPS



AUTOMATIC



SPRINKLERS

The famous Quartz bulbsprinkler head. In most cases sprinklers will reduce insurance expense from 50 to 90 percent.

Where air dryness adversely affects processes, large savings are made by our humidification equipment.

HUMIDIFIERS

POWER

a great welding job for—

one of the two largest institutions for the insane in this country—the Manteno State Hospital.

The power house piping is a welded job as far as it was practical and, where possible, shop fabricated welding was installed with square corner—full thickness—lap joint flanges for connecting together. This means economy of installation.

"Triple XXX", the mark of quality, is found on all Grinnell power piping materials and on Grinnell welded joints for high pressures. It represents our engineering experience, our rigid laboratory standards and our facilities for fabrication . . . Bends, Loops, Extra-heavy lap joints, Universal forged hangers, Adjustable Bracket Assemblies, etc.

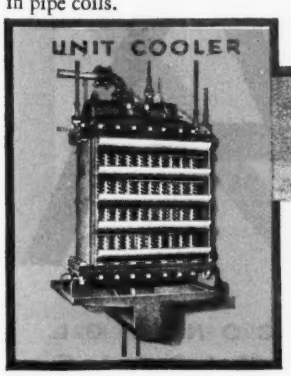
GRINNELL COMPANY INC.

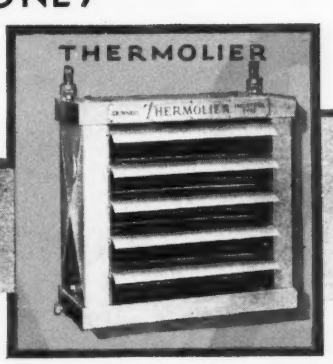
Branches in all principal cities

Executive Offices: Providence, R. I.

WILL SAVE MONEY

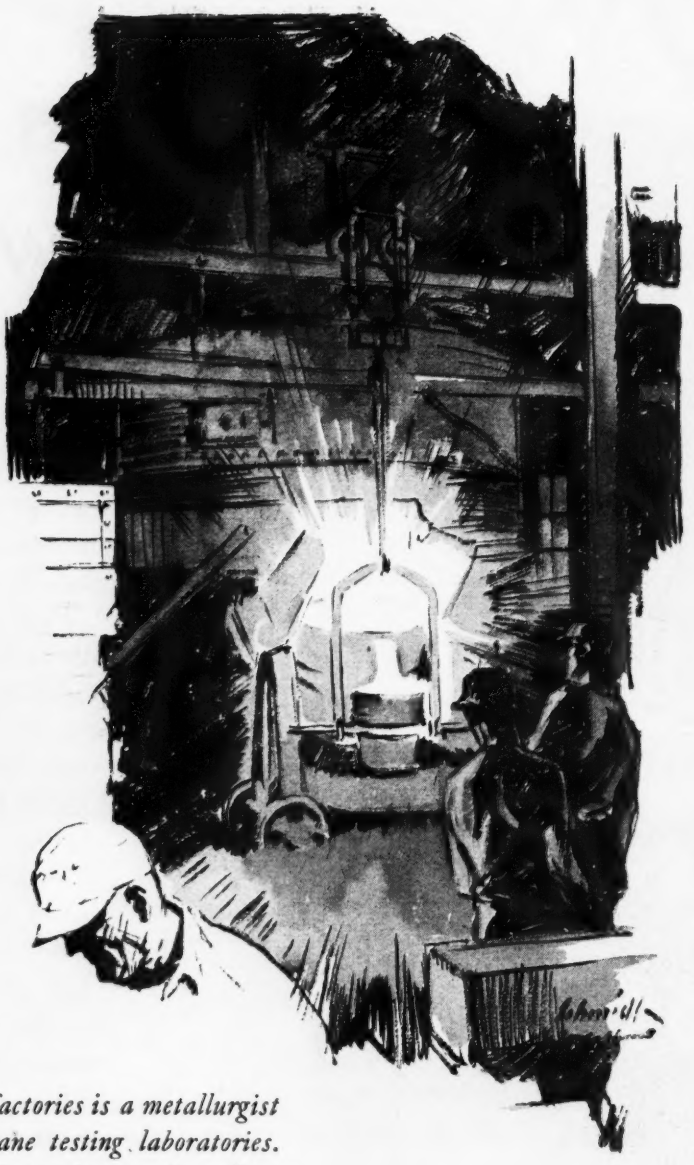
A revolutionary improvement in refrigeration. It replaces more than ten times its weight in pipe coils.





This remarkable Unit Heater is a better and cheaper means of heating industrial and commercial buildings. Heating systems can usually be modernized almost over-night, with a tremendous saving on fuel.

Pipe fabrication, lap joints, pipe bends, forged hangers and welded headers comprise the Triple XXX line for Super Power work. By modernizing to use high temperature steam your yearly savings will often run to five or six figures.



For each cupola in Crane factories is a metallurgist who is a graduate of Crane testing laboratories. For each hour of his run, he receives an immediate report from the laboratories and studies it to make sure his metal is running true to specification.

CRANE

PIPING MATERIALS TO CONVEY AND CONTROL STEAM, LIQUIDS, OIL, GAS, CHEMICALS

ONCE EVERY HOUR

Once every hour, the cooks who make the batter that is moulded into the Crane valve cake sample their wares.

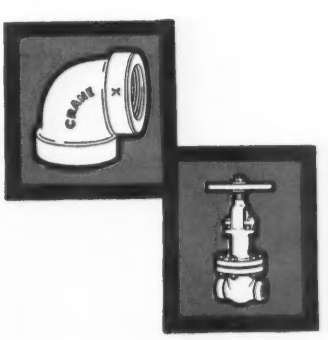
Once every hour, testing bars are drawn off from the mass of white hot metal in Crane cupolas and sent to testing laboratories. There they are tested for yield point, breaking points, elongation, tensile strength, transverse strength, in machines that measure to .00005 of an inch.

But this is by no means the full story of the sleepless vigilance kept by Crane men over their products. Before physical tests of metals comes laboratory analysis of all ingredients that go into them. Silicon, manganese, carbon, phosphorus, sulphur, pure iron, all are kept unadulterated and properly proportioned to standards. After physical tests of metals comes mechanical tests of completed materials. Of one kind and another, more than 5000 tests a day are made in Crane factories. And any new materials or new designs are painstakingly proved in service before being offered for general use.

Result: Crane engineers beyond any reasonable doubt know exactly what each separate valve that is shipped to you will do in service. They are enabled to recommend for your piping installation materials proved and amply strong for service, safety, and endurance. They need never recommend materials stronger and costing more than the use requires. They will be glad to advise you.

In Crane laboratories, at machines like this measuring to .00005 of an inch, the test bars that are drawn every hour of the day's run are broken.

N E



GENERAL OFFICES: 836 SOUTH MICHIGAN AVENUE, CHICAGO • NEW YORK OFFICES: 23 W. 44TH STREET

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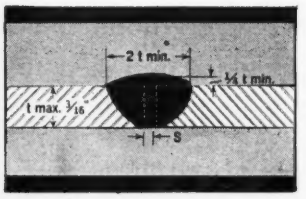
OXWELDING

A New Era In Piping



DESIGN STANDARDS FOR OXWELDED PIPING

Any welded piping system, even in its most complicated form, is a combination of a few fundamental welding design details.

WELDED LINE JOINTS

Open Square Butt Weld

Explanation of Design:

The Open Square Butt Weld illustrated is used mainly for thin-walled pipe, with which sufficient weld depth penetration can be obtained without beveling, due to the melting of the steel with the blowpipe flame.

Uses:

The Open Square Butt Weld is recommended for standard pipe up to 2½ in., extra heavy up to 1½ in., and for all pipe having a wall thickness of 3-16 in. or less, for all services.

Specification:

When the Open Square Butt Weld is specified the following features should be included in the specifications:

1. For the smaller sizes of pipe, spacing between ends shall be as indicated in Table 1, page 11, "Design Standards for Oxwelded Piping." For sizes larger than 4 in. spacing shall be 3-16 to ¼ in.
2. Welds shall be thoroughly fused to the depth indicated in the drawing.
3. Welds shall have a minimum width of twice the pipe wall thickness and shall be symmetrical with the center line of the joint.
4. Welds shall be built up to present a gradual increase in thickness from edge to center.
5. Weld reinforcement shall be at least the minimum shown in the drawing.
6. The weld shall be of sound metal free from laps, gas pockets, slag inclusions or other defects.

The above is excerpted from a handbook on fundamental designs, titled, "Design Standards for Oxwelded Steel and Wrought Iron Piping," published by The Linde Air Products Company. You should have a copy of this handbook. It is yours for the asking.

ECONOMY in the transmission and use of liquids and gases in most cases requires high working pressures and these have been ever on the increase during late years. High working pressures have brought about an entirely new conception of practical pipe joints and fittings. Oxwelding has become the standard means of pipe jointing, as a result of this new era, for high pressure piping as well as for piping operated under normal pressure.

An oxwelded joint is stronger than any other type of construction. In strength it is equal to, and if the weld is built up above the surface, greater than the strength of the pipe itself. It is also permanently tight and after testing may be forgotten. It has the same resistance to corrosion as the pipe wall.

Under Procedure Control, welded piping construction may be undertaken with the same confidence in a satisfactory result as older methods, and with further assurance of increased economy and serviceability.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

126 Producing Plants — UCC — 627 Warehouse Stores

IN CANADA, DOMINION OXYGEN COMPANY, LTD., TORONTO

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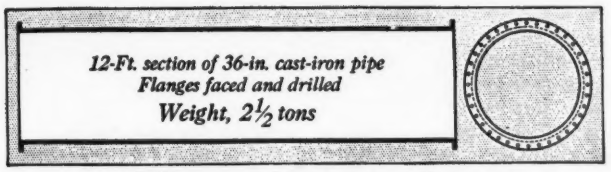
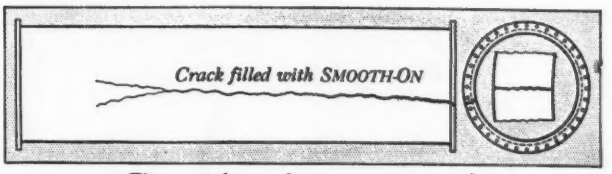
Denver	Minneapolis	Seattle
		Tulsa

LINDE OXYGEN · PREST-O-LITE ACETYLENE · OXWELD APPARATUS AND SUPPLIES · UNION CARBIDE



New pipe section



Crack after repair

A PERFECT REPAIR—at *less than 2%* of renewal cost

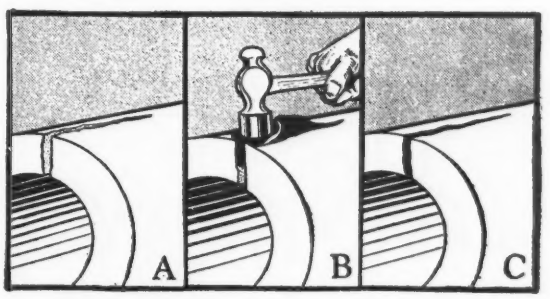
A MASSACHUSETTS station serving a large mill has a 24-ft. horizontal run of 36-in. cast-iron pipe between a barometric condenser and a 1500-kw. steam turbine.

Shortly after starting one morning a heavy water hammer developed and the Engineer was forced to shut down and drain the condenser. On attempting to start up again, vacuum could not be restored because a 12-ft. pipe length in the horizontal line had cracked lengthwise for 10 ft. The crack extended through one flange as shown, and at the flange end was open about ⅛ inch.

The outer edges of this crack were cut V-shape with a diamond point tool, and the crack was tamped full of SMOOTH-ON No. 1, as shown in the diagrams. This seal has proven perfect, and for all practical purposes the pipe section is as dependable as a new one, which could have been installed only at great time loss and labor expense, to say nothing of buying a new pipe section of that size.

The SMOOTH-ON Handbook contains instructions and diagrams for making hundreds of equally practical emergency and routine repairs, and should be on your desk for quick reference.

Get SMOOTH-ON *in 1 or 5-lb. can or larger steel keg from your supply house or if necessary, direct from us.*

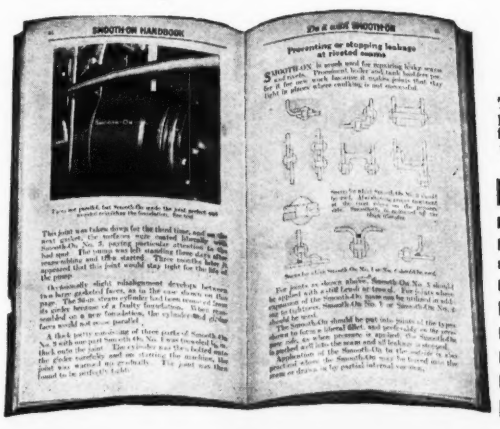


The easiest way of applying SMOOTH-ON to make a pressure-tight seal at cracks or breaks in metal.

Cracks or breaks of sufficient depth to permit SMOOTH-ON No. 1 to be hammered, forced or caulked directly into the opening are tightly sealed through the hardening of the SMOOTH-ON and its expansion while doing so.

All fluid and pressure should be removed from the metal, grease and dirt cleaned away (A) and a sharp-pointed tool run along the edges to slightly open the crack so that the SMOOTH-ON can enter. SMOOTH-ON No. 1 mixed to a soft putty should be applied over the crack and tamped in with a hammer (B), working all along the crack. The SMOOTH-ON which spreads away should be brought back over the crack and the tamping continued with light blows until the crack is deeply filled. The excess of SMOOTH-ON should then be removed from the surface (C) and the filling allowed to set until the SMOOTH-ON becomes hard like iron, after which the repair is ready for service.

This method is equally applicable to any metal—steel, iron, brass, copper, lead and aluminum, and for low and moderate pressure service make a permanent repair.



THE SMOOTH-ON HANDBOOK
FREE if you return the coupon

Twenty-first Edition—136 pages of data—193 diagrams, pictures and practical hints on at least 200 different uses for SMOOTH-ON. Every progressive engineer should have this book—get your copy, NOW.

SMOOTH-ON MFG. CO.
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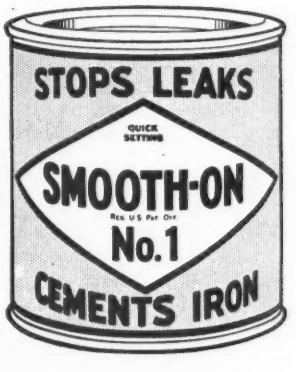
6-30-31



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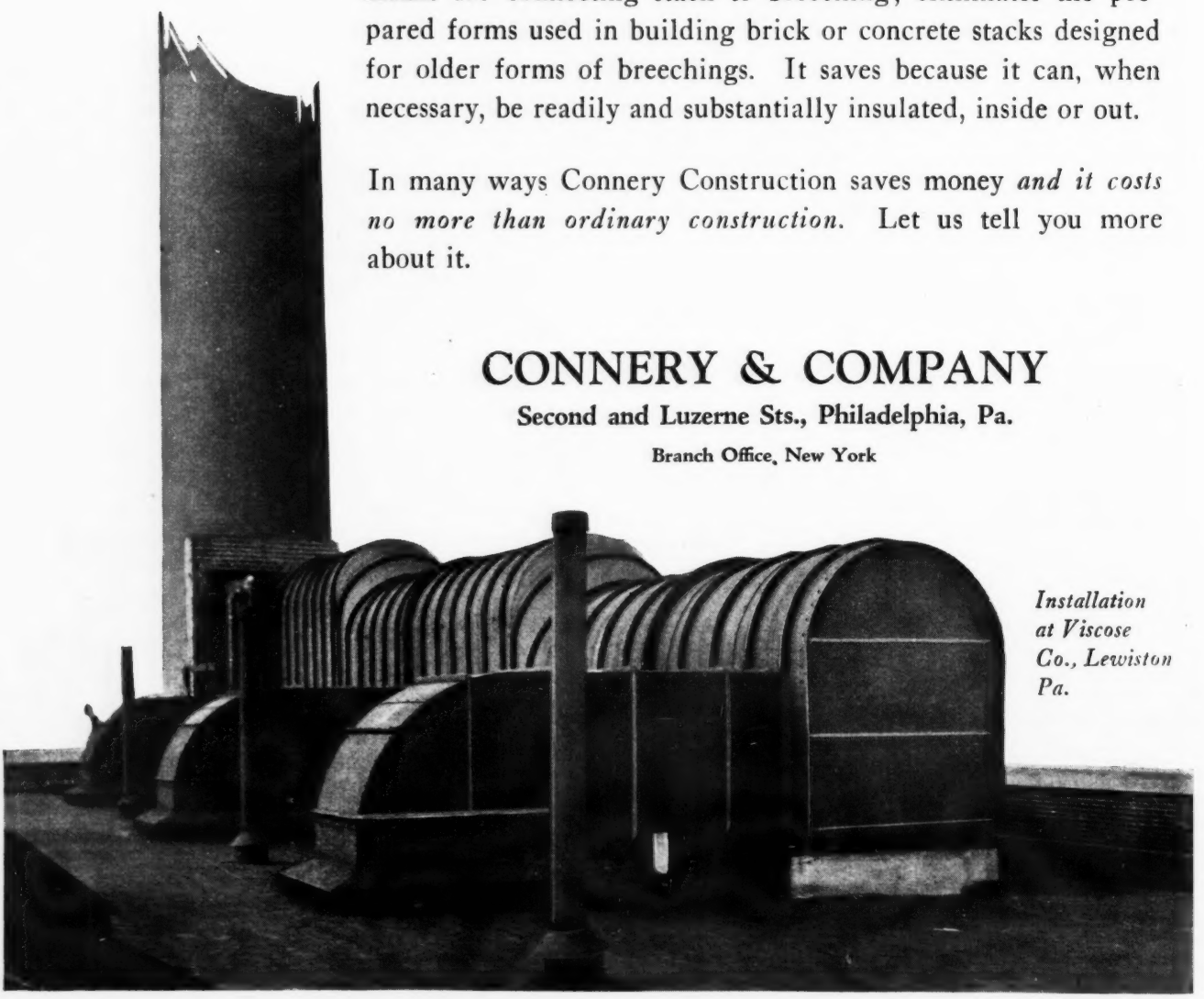
YOU SAVE MONEY

in more ways than one when you install

CONNERY CONSTRUCTION

Connery Construction saves because it is long-lived; it doesn't warp or buckle. It saves because it is tight; it doesn't leak heat out or moisture in. It saves because it provides a simple, secure means for connecting stack to breeching; eliminates the prepared forms used in building brick or concrete stacks designed for older forms of breechings. It saves because it can, when necessary, be readily and substantially insulated, inside or out.

In many ways Connery Construction saves money *and it costs no more than ordinary construction.* Let us tell you more about it.



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CONNERY & COMPANY

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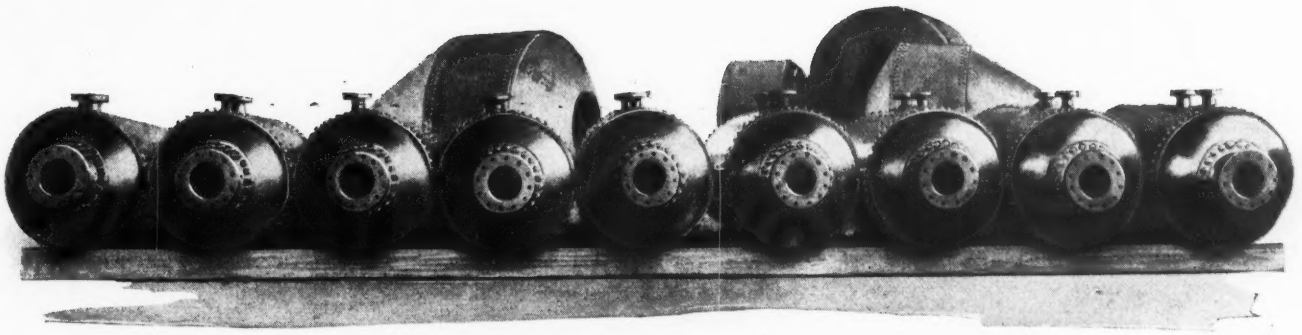


SHOOTING SUPERHEATER and TURBINE TROUBLES

SLUDGE and water in steam from priming or foaming boilers often bring disaster to superheaters and turbines.

In one steam plant the intervals between renewals of superheater tubes averaged four days; another plant had to send the rotor of the main turbine back to the builder for reblading, the trouble in both cases being due to dirty steam. And in both instances the trouble was permanently cured by the installation of

COCHRANE STEAM PURIFIERS

Located in the steam connection between boiler drum and superheater, a Cochrane Purifier insures clean, dry steam, regardless of the boiler water concentration and at any rating at which the boiler may be regularly operated. It leaves the full volume of the steam drum available to absorb water level fluctuations.

It does not clog up or require cleaning.

It is heavily constructed and outlasts the boiler itself.

Ask for Cochrane Bulletin L-684, on "Steam Purification."

COCHRANE CORPORATION

17th & Clearfield Streets, Philadelphia, Pa.

S-16

Ebb Tide

Tides rise and tides fall. One moment the spray blows over grass and bushes at the very edge of the water. Six hours later you see long stretches of sand and mud and rocks covered with seaweed.

As in all the swings of nature, the movement is least when the change is fastest. At half tide the water moves up and down the beach at a noticeable pace, but at top and bottom, when fundamental changes are at hand, it appears to go dead. Stagnation marks flood and ebb alike.

I am no economist, and have no license to poach on the happy hunting grounds of business cycle experts. But as an engineer who has some appreciation of the dollar I may be permitted a few remarks. Let me speak also as a lover of the sea, who has watched the tides in many a harbor, and applied their lessons in other fields.

When the ebbing tide slackens I know something is happening. When it ceases to move—when the waves lap again and again to the same pebble—I know the flood must start before long. It never fails.

Another thing I know. If there is work to be done at high tide I must get started at the ebb—must drive stakes, build platforms and assemble tools while the water is low; otherwise the rising tide will find me unprepared, still busy getting started when I ought to be doing the job.

In business the tide is down. Everybody knows that. What is more—and what some fail to see—is that the water now is slack and that this clearly indicates an early start of the flood. It is high time to get started on all jobs that must be in swing when the water is up.

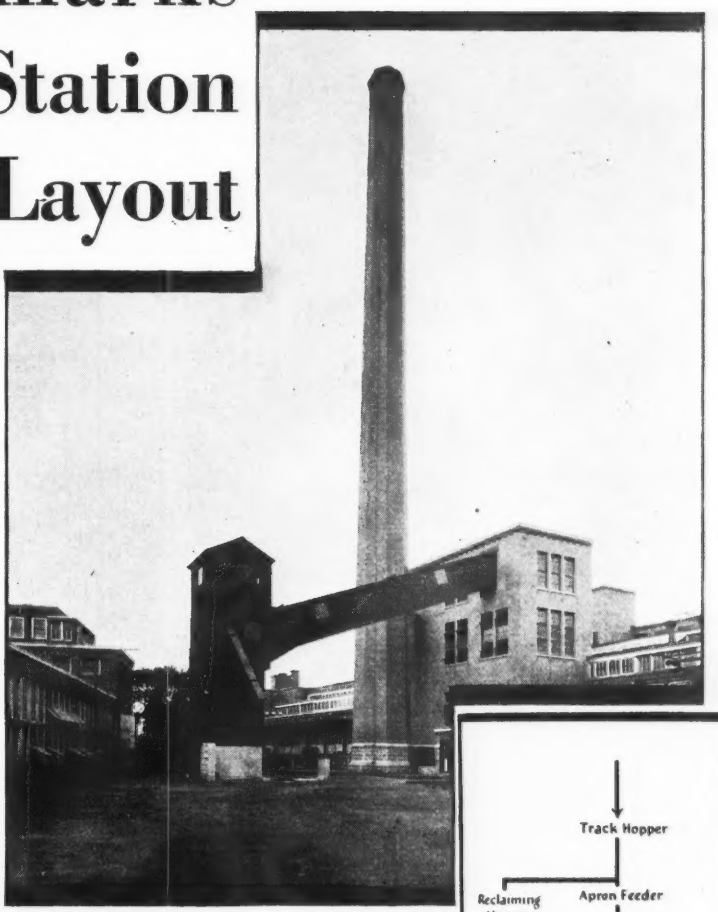
In the power plant that means suitable equipment in shape for efficient, trouble-free operation. In factories it means production machines tuned up, products and manufacturing methods perfected, organizations well oiled. In sales it means markets well studied, products set to go in fields already subjected to intensive cultivation.

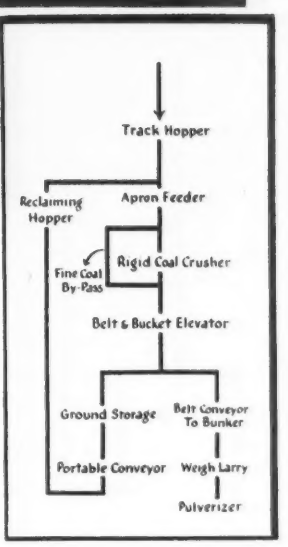
An hour's delay at the ebb is nothing—then—but it's a foot of water three hours later. The time to get moving is now.

George Edwards.
Engineer

All the Earmarks of a Central Station Coal-Handling Layout

. . . . yet it is for a moderate size industrial power plant.





A CERTAIN manufacturing company wanted a modern coal-handling system for its present power plant. It also wanted to be able to expand later, utilizing the layout and equipment initially installed.

Robins engineers designed, equipped and erected a system compact and efficient for present needs yet capable of expansion for future needs. The coal now moves as shown in the sketch.

For expansion purposes, the ground-storage will be enlarged and the coal reclaimed to the same hopper by drag scraper instead of by portable conveyor. The bunker will be extended. The present conveyor from the elevator to the bunker will be lengthened to run over the enlarged bunker and a tripper installed to take care of the bunker distribution. Otherwise, the equipment and layout will remain essentially the same.

This company now has a coal-handling layout that was low in cost to begin with and amply meets present requirements, yet one that can be greatly expanded without scrapping any of the important elements now in use.

This is a good example of Robins service to industrial plants in connection with their coal-handling problems.

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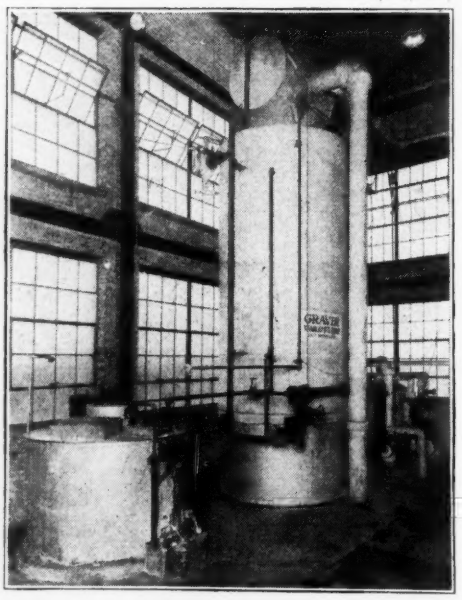

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54 Meat Packing Plants

ONE of the above companies has been using the K.W.S. System for 8 years, another for 7 years. These two are among the largest meat packers in the world.

Facts like these speak for themselves.

It is hardly necessary to state that at one time these plants suffered from most of the ills common to boiler feedwater—scale, foaming and corrosion; that they experienced the resulting tube losses, heavy lubrication and fuel bills and general inefficiency.

The plants referred to are under the supervision of high-class, intelligent men. They can get what they want or need. They are eager to cut costs wherever possible because meat is sold on a small margin of profit and consequently every worth while saving is important. That is why these men use the K.W.S. System. If there were a better system they would adopt it. They are hard to sell but when they find what they want they stick to it.

The K.W.S. System appeals to the intelligent man because he can quickly see that it is sensible and logical; because it is scientific and simple and because it should be positive in results.

use the K.W.S. SODIUM ALUMINATE SYSTEM

No. 16
of a series describing customers who use the K.W.S. SYSTEM

A few minutes a day testing the boiler water and reporting to us saves hours spent on boiler cleaning and tube replacement. It may also avoid some explanations to the boss why the fuel and lubrication bills are high. And above all that, you have that satisfactory feeling that comes of having solved a difficult problem; of knowing that you have as close as your telephone, a group of trained men who are always ready, able and willing to help you out on any unexpected problem in connection with your feedwater.

The service that goes with the K.W.S. System is just as valuable and important as the chemicals used.

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Would you be INTERESTED?

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☐ Please send me your booklet—"Standardized Feedwater Treatment," free of charge.

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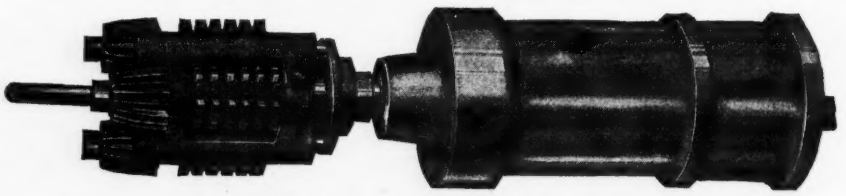
Four Cleanings a Year May Be Cheaper Than One

The average cleaning time per boiler is reduced by more frequent cleaning and more uniform efficiency of the boiler is maintained.



Roto 4" Heavy Duty Air-Driven Tube Cleaner

Roto Cleaners can also be furnished for various sizes and types of tubes.

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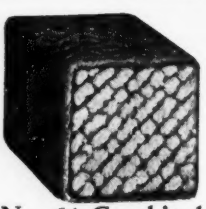

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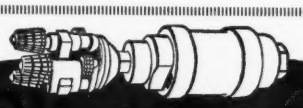

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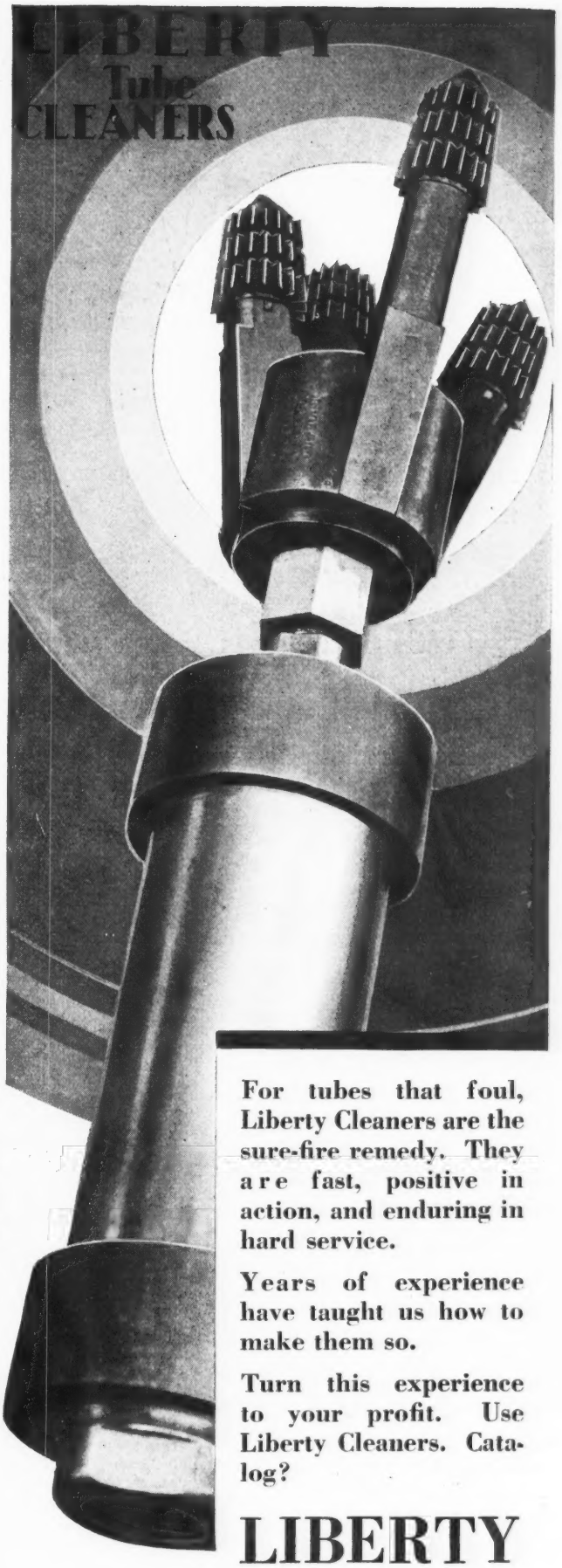

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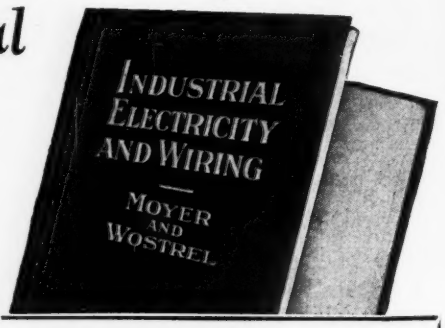

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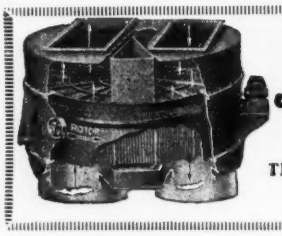

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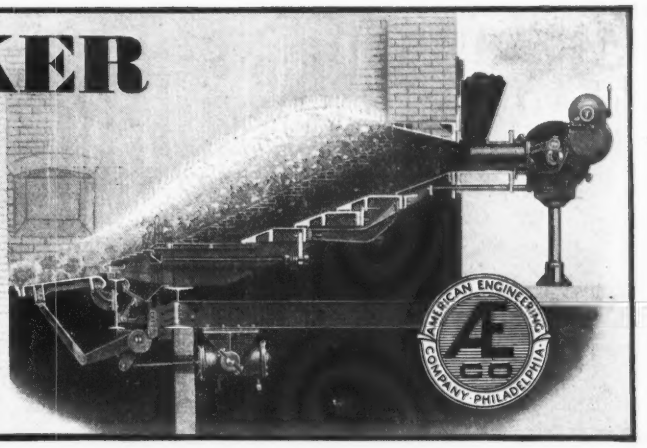

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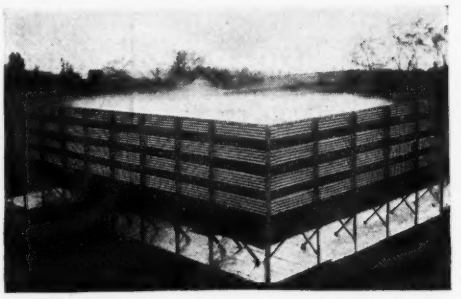

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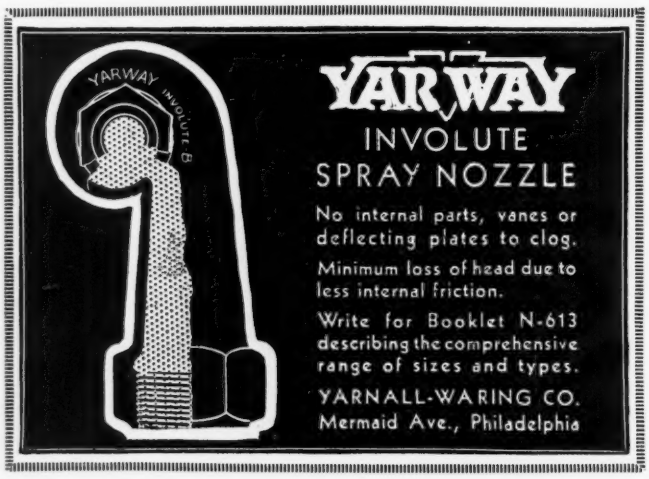
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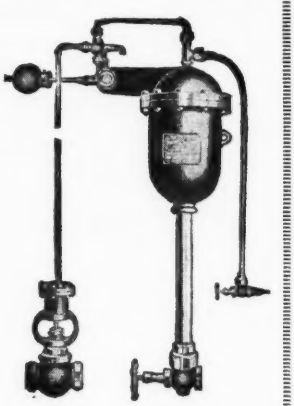

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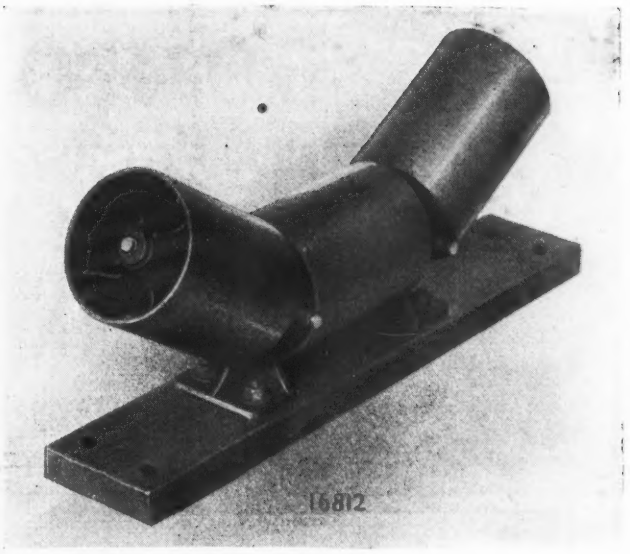

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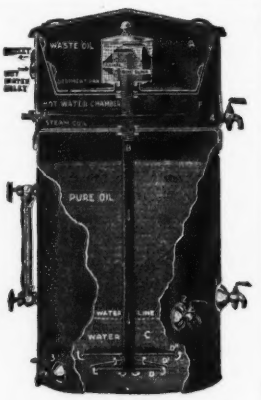

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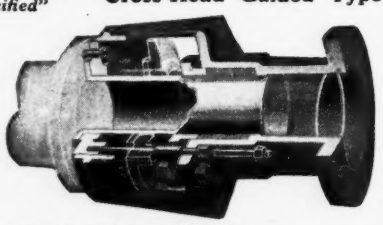

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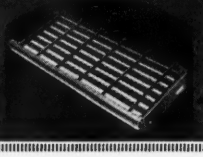

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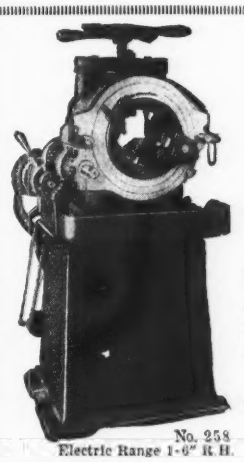

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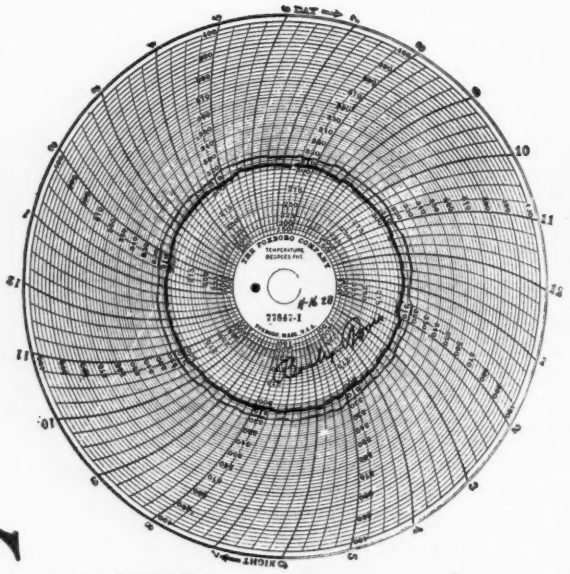

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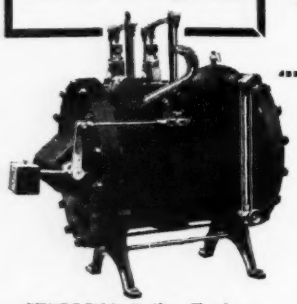

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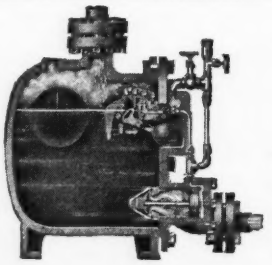

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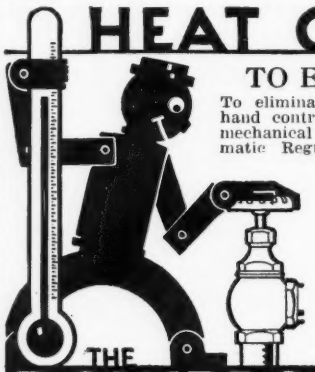

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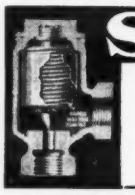

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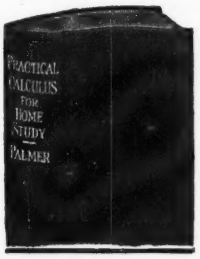

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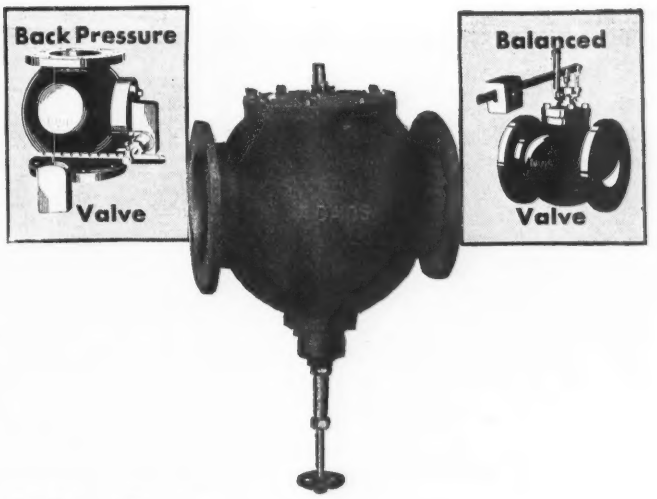

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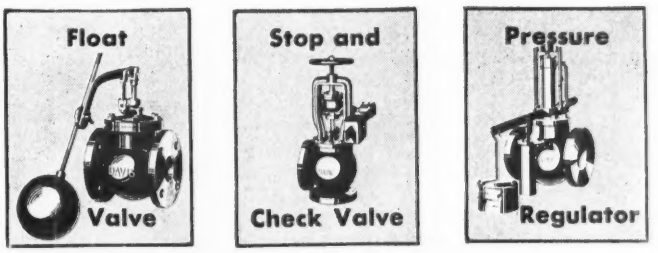

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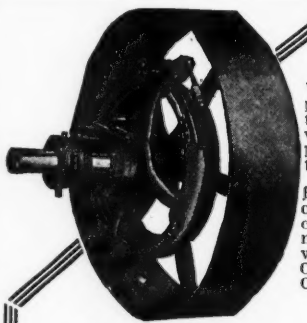

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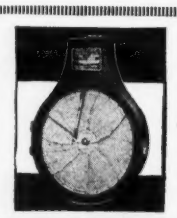

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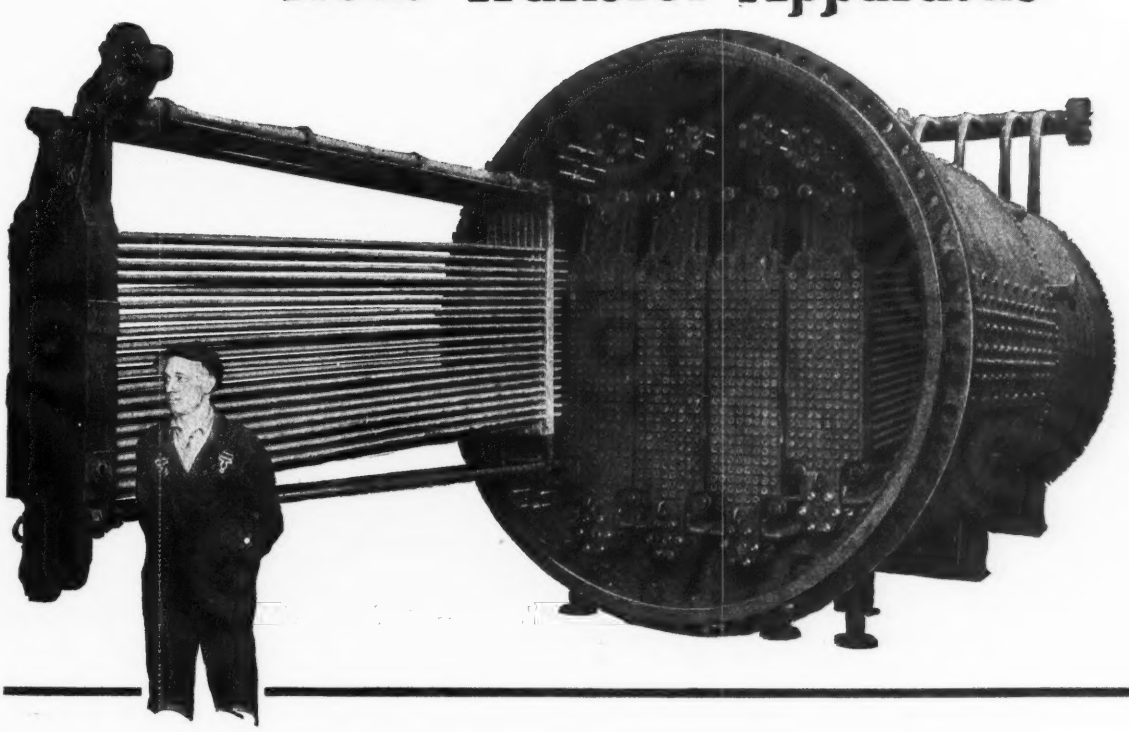

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are ready to help you solve your power plant problems—to help you get greater efficiency with lower costs.
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BOILER WATER CONDITIONING
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Appraisals, Power Plant Construction, Design, Renovation, and tests. Electrical Distribution. Switchboard Layouts.
86 Essex St., Boston, Mass.

W. S. LEE ENGINEERING CORPORATION
CONSULTING ENGINEERS
Hydro-Electric Developments.
Central Steam Stations.
Industrial Buildings.
Institutional Buildings.
535 Fifth Avenue, New York — Power Building, Charlotte, N. C.

CHAS. T. MAIN, INC.
ENGINEERS
Electrical, Steam and Hydraulic Power
Industrial Buildings
Valuations and Reports—Consulting Engineering
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Power Plants—Mechanical and Electrical Equipment—Heating and Ventilating
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Electric Power and Industrial Plants
Electric Furnace Engineering
Development, Design, Supervision
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Coal, Ash, Oils, Water, Metals
Electrical and Power Plant Tests
Inspectors of Materials
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CONSULTING ENGINEERS
Power and Industrial Plants and Processes.
Water, Gas and Electric Systems.
Commercial Trust Bldg.,
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Electrical and Mechanical Engineering, Supervision and Management
Steam, Gas, Water and Electrical Construction.
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Write or call. No obligation.
LAwndale 3378. 29 E. Lakeview, Columbus, Ohio

FRANCIS J. SILL
HEAT and POWER ENGINEERING
as applied to Industrial Plants
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Westboro, Massachusetts

W. J. SQUIRE
CONSULTING ENGINEER
Railways—Power Plants
Industrial Power and Illumination
Transmission Lines, Appraisals and Reports
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JOHN A. STEVENS, INC.
Established 1909
CONSULTING ENGINEERS
Power Plants — Paper Mills
Dye Houses — Surveys
Lowell, Massachusetts

Modernization means more—

than scrapping old machinery and equipment. Modernization means scrapping old ideas, out-of-date policies, rule of thumb methods. Modernization means wiping the cobwebs out of your own brain and letting in the sunlight of modern ideas. Modernization means consulting this directory if you need expert professional advice on any of your electrical engineering problems.

SEARCHLIGHT SECTION

EMPLOYMENT : BUSINESS : OPPORTUNITIES : EQUIPMENT—USED or SPECIAL

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EMPLOYMENT SERVICE

IF YOU are qualified for position between $2,500 and $25,000 and are receptive to negotiations for new connection, your response to this announcement is invited. The undersigned provides a thoroughly organized service, established twenty-one years ago, to conduct confidential preliminaries, and assist the qualified man in locating the particular position he desires. Not a registration bureau. Retaining fee protected by refund provision, as stipulated in our agreement. Send name and address only for description of service. R. W. Bixby, Inc., 270 Main Street, Buffalo, New York.

EMPLOYMENT AGENCY

AMERICAN Engineers Service, Harrisburg, Pa. Require graduate mechanical-electrical superpower plant maintenance, heating, combustion, testing engineers, draftsmen, student cadets.

POSITION WANTED

DISTRICT heating engineer, executive. Experience in design, construction, operation, sale, customer contact, and all phases district heating business with large utility. Engineering graduate, age 35. Any location. PW-78, Power, Tenth Ave. at 36th St., New York.

REPRESENTATIVE AVAILABLE

New York City Representatiion

Engineering concern desires additional high class line for metropolitan district. G. H. Bolle, 120 Liberty St., New York City.

BUSINESS OPPORTUNITY

OWNER of meritorius patent on thermostatic valve desires the active partnership of mechanical engineer, familiar with this line and possessing sufficient capital to market same. Exceptional investment opportunity. Theander, 111 Court St., Brooklyn, N. Y.

U. S. Government

TREASURY DEPARTMENT, Office of the Supervising Architect, Washington, D. C., June 13, 1931.—Sealed bids in duplicate subject to the conditions contained herein, will be publicly opened in this office at 3 p.m., July 15, 1931, for furnishing all labor and materials and performing all work for the remodeling of mechanical equipment, etc., at the U. S. court house, Santa Fe, N. M. The prevailing rate of wage shall be paid all laborers and mechanics employed on the project as provided in the Act of March 3, 1931 (Public No. 798). Drawings and specifications, not exceeding one set, may be obtained by any satisfactory general contractor at this office in the discretion of the supervising architect. JAS. A. WETMORE, Acting Supervising Architect. (231)

WANTED TO BUY

PART OR WHOLE OF SMALL ELECTRIC UTILITY CO.

W-77, Power
Tenth Ave. at 36th St., New York City

ONE AERO PULVERIZER

Capacity 6,000 lbs. bituminous coal per hour, driven by a Westinghouse 100 hp. turbine, both good condition. Detailed information will be furnished on request.

B. B. BRAIN, Pur. Agent
The Kansas City Sou. Ry. Co.
KANSAS CITY, MISSOURI

FOR SALE

1—1000 KW. General Electric turbo generator, extraction type, five years old.

1—1500 KW. General Electric extraction type turbo generator.

1—3000 KW. General Electric condensing turbo generator.

2—300 KW. General Electric non-condensing turbo generators.

Motors, Dynamos, Transformers, Engine Generators, Motor Generators, Rotary Converters, Power Plant Equipment of all kinds.

Your inquiries solicited.

GEORGE SACHSENMAIER CO.
8403 Hegerman St., Philadelphia, Pa.

SLIP-RING MOTORS—3 PH., 60 CY.

Hp.	Volts	Make	Speed
220	220–440	G.E.	450
200	440–220	G.E.	600
150	2200–440–220	G.E.	514
150	220–440–550	G.E.	600
100	2,200	Westingh'se.	900
100	2,200	G.E.	720
100	550	G.E.	720
100	440–220	G.E.	720
100	440–220	G.E.	900
100	550	Westingh'se.	900
75	440–220	G.E.	600
60	440–220	G.E.	720
50	440–220	Westingh'se.	720

MOTOR-GENERATOR SETS AND ROTARY CONVERTERS

1—300 Kw., 250-v., 1,200-r.p.m., G.E., connected to 2,300-440-v., 3-ph., 60-cy., synchronous motor
1—100-kw., 250-v., 6-ph., 60-cy., 1,200-r.p.m., Westinghouse, with 2,300-v., transformers.
1—50-kw., 125-v., 1,200-r.p.m., G.E. R.C., connected to KT., 2,200-440-220-v., 60-cy., squirrel cage motor.
1—25-kw., 125-v., 1,800-r.p.m., G.E.R.C., connected to KT., 440-220-v., 60-cy., squir. cage motor.

A.C. GENERATORS

1—225-kva., 600-r.p.m., 240-480-v., G.E.
1—187-kva., 720-r.p.m., 2,200-440-220-v., G.E.
1—150-kw., 900-r.p.m., 2,200-480-240-v., G.E.
1—120-kva., 900-r.p.m., 2,300-4,000-v., G.E.
1—112½-kva., 900-r.p.m., 2,200-240-480-v., G.E.
1—75-kva., 1,200-r.p.m., 2,200-480-240-v., G.E.
1—56-kva., 1,200-r.p.m., 240-480-v., G.E.
1—50-kva., 1,200-r.p.m., 2,300-480-240-v., G.E.

STEPHEN HALL & CO., INC.
691 Adams Street, Hoboken, N. J.

DIESEL ENGINES

AT LOW PRICES

A few of the engines which we have:

40 hp. De La Vergne "DH".
65 hp. De La Vergne "DH".
80 hp. Fairbanks Morse and Generator.
85 hp. Bessemer and Generator.
100 hp. Fairbanks Morse.
120 hp. Bethlehem, new.
180 hp. Bessemer.
200 hp. vertical De La Vergne and Generator.
200 hp. Fairbanks Morse and Generator.
300 hp. Fairbanks Morse and Generator.

Robert P. Kehoe Machinery Co.
51 East 42nd Street, New York

MOTOR GENERATOR SETS

1—500 kw., 250 v. Westinghouse Synchronous Motor Generator Set.
1—300 kw., 125 v., 3-wire, 3-unit, Ridgeway.
1—250 kw., 230 v., 3 ph., 60 cy., 2300-4600 v. Synchronous Motor Generator Set.
1—200 kw., 230 v., 3 ph., 60 cy., 2300-4100 v. Synchronous Motor Generator Set.
1—150 kw., 600 r.p.m., 250 v., Gen., 3 ph., 60 cy. 220-440 v., G. E., Synchronous Motor.
1—125 kw., 250 v. Westinghouse Synchronous Gen. Motor Set, 3 ph., 60 cy., 230-2200 v.
1—100 kw., 125 v., D. C. 220-440 A.C. G. E. Synchronous Motor Generator Set, 220-440 v.
1—100 kw., 250 v. Gen., 900 r.p.m., 2200 Synchronous Motor.

TURBINES

1—500 kva. Westghse. Non-Condensing Turbine.
1—75 kva., 3 ph., 60 cy. Westghse. Geared Non-Condensing Turbine.

TRANSFORMERS

1—1500/3000 kva. G. E. combined oil and water cooled 3 ph., 60 cy., 11000-22000-2300 v
2—500 kva. G. E. 13000/26000—220/440.
3—333 kva. G. E. 4150—110/220.

A.C. GENERATORS

No.	*Kw.*	*R.p.m.*	*Volts*	*Ph.*	*Type*
1	400	900	2300-4000	3	Westg.
1	350	600	440	3	Westg.
2	125	900	2300	3	Cr.-Wh.
2	100	900	230-2300	3	G.E.
1	75	600	220	3	Westg.
1	75	900	2300	3	G.E.
1	50	1200	220-440-2300	3	G.E.

MOTORS

Complete line of A.C. and D.C. Motors.

J. L. HEMPHILL & CO., Inc.
Electrical Engineers and Equipment
801 William St., North Bergen, N. J.

TURBINES A. C.

2500 KVA. G.E. (condensing).
1875 KVA. Wghse. (bleeder).
1250 KVA. Wghse. (bleeder).
1250 KVA. (2) G.E. (condensing).
937 KVA. G.E. (condensing).
780 KVA. Wghse. (bleeder).
625 KVA. Wghse. (40 lbs. b.p.).
625 KVA. Wghse. (bleeder).
375 KVA. Wghse. (non-condensing).

ENGINE SETS A. C.

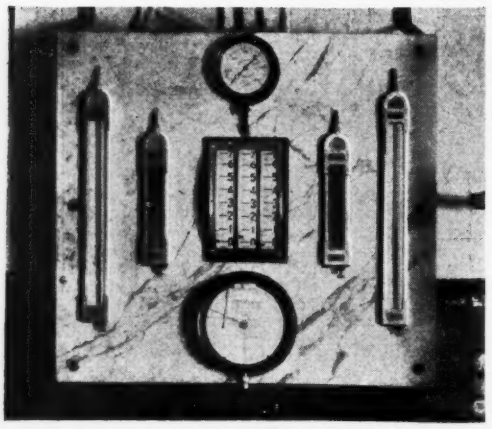
780 KVA. G.E.—24-30 Erie Ball 4 v.
500 KVA. C.W.—24x30 Chuse 4 v.
500 KVA. G.E.—20x30 Ames Uniflow.
312 KVA. G.E.—18x22 Erie Ball 4 v.
312 KVA. G.E.—21x22 Skinner Uniflow.
240 KVA. G.E.—16x24 Chuse 4 v.
187 KVA. G.E.—19x20 Skinner Uniflow.
150 KVA. G.E.—14x16 Skinner Uniflow.

Power Plant Equipment Co., Inc.
39-41 Cortlandt St., New York City, N. Y.

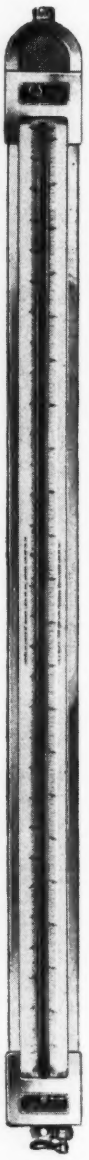
520 HP Busch Sulzer Diesel **Oil Engine Direct Coupled to 350 Kw. Generator** 3 phase, 60 Cycles, 220-440-2300 Volts or 125/250 Volts—3 Wire D.C.
2—352 **HP Heine Boilers**—180 lbs.
50 Kva. Westgh.-Harrisburg 3 Phase, 60 Cycles, 220/440/2300 Volts.
42 Kw. G. E. Chuse 125/250 Volts, 3 Wire
62 Kw. G. E. Chuse, 125/250 Volts, 3 Wire
82 Kw. G. E. Harrisburg, 250 volts, D. C.
100 Kw. Westghse.-Harrisburg 4 Valve, 125/250 Volts, 3 Wire
110 Kw. Bullock Chuse 4 Valve, 125 Volts, D.C.
125 Kw. Genl. Elect. Ideal, 250 Volts, D.C.
150 Kw. Genl. Elect Erie City, 125 Volts D.C.
350 Kw. Genl. Elect. Sprague D.C. Generator, 125/250 Volts, 3 Wire, 200 RPM.
425 Kw. Bullock Allis-Chalmers Simple Corliss A.C. Unit, 3 Phase, 60 Cycles, 220-440 2300 Volts
625 Kva. Genl. Elect. Fulton Simple Corliss A.C. Unit, 3 Phase, 60 Cycles, 240-480 Volts

ARTHUR S. PARTRIDGE
St. Louis, 419 Pine Street

THE K.S. TELEGAGE FOR LIQUID MEASUREMENT
ACCURATE—DEPENDABLE



A typical power plant installation



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The Telegage based on the U-tube principle—no floats, no gears, no diaphragms, wires or moving parts—is the simplest scientific method of liquid measurement. Reliability because of simplicity is one of the reasons Power Engineers are using the Telegage for checking oil level in transformers, oil level in main bearings, Diesel fuel supply etc., etc.

The Telegage is serving a useful and economical purpose wherever the depth, level, volume or weight of a liquid need be known. Your inquiry will bring complete details.

TELEGAGE

KING-SEELEY CORPORATION
ANN ARBOR MICHIGAN

Offices in
Chicago, Cleveland, Detroit, Milwaukee, New York
Philadelphia, St. Louis and Toronto

Manufacturing Associates
London, England and Paris, France

Some One Wants To Buy

the equipment or machinery that you are not using. This may be occupying valuable space, collecting dust, rust and hard knocks in your shops and yards.

Sell it

before depreciation scraps it.

The Searchlight Section is helping others— Let it help you also

GN-034

MONEY WELL SPENT

Says a prominent consulting engineer:

"IT is the smaller equipment in a power plant which is the greatest potential source of trouble, and since this smaller equipment costs relatively little compared to the plant as a whole, it is evident that money spent for the very best that can be had in the way of designs and materials for the smaller items of equipment is money well spent."

Obviously Diamond Soot Blowers and Diamond "Loose Window" Gauges and Water Columns meet the specification of "Money well spent!"

PREFERRED FOR PERFORMANCE

DIAMOND POWER SPECIALTY CORPORATION
DETROIT . . . . MICHIGAN

What and Where to Buy

Names of manufacturers and distributors supplying equipment apparatus and supplies used in power services whose advertisements appear in this issue . . . This index is published as a convenience to the reader. POWER assumes no responsibility for errors or omissions.

Acetylene, Dissolved
Linde Air Products Co.

Air Aftercoolers & Receivers
Foster Wheeler Corp.
Griscom-Russell Co.
Penn. Pump & Cmprsr. Co

Air Chambers
Hercules Float Works

Air Heaters
Riley Stoker Corp.

Air Washers
Buffalo Forge Co.
Spraco Inc.

Arches, Boiler
Lavino & Co., E. J.

Ash Handling Equipment
Allen Sherman Hoff Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Riley Stoker Corp.
Robins Conveying Belt Co.
United Conveyor Corp.

Baffle Walls, Boiler
King Refractories Co.

Bearings
Robins Conveying Belt Co.
Timken Roller Bearing Co.

Belt Dressing
Texas Co.

Belting & Belt Drives
Greene Tweed & Co.

Bins, Bunkers, Coal & Ash
Allen Sherman Hoff Co.
Link-Belt Co.
United Conveyor Corp.

Blowers, Fan
Buffalo Forge Co.
Clarage Fan Co.
Jeffrey Mfg. Co.
Schubert-Christy Corp.
Wing Mfg. Co., L. J.

Blowers, Soot
Diamond Power Spec. Corp.
Vulcan Soot Cleaner Co.

Blowers, Steam Jet
Chesterton Co., A. W.

Boiler Blow Down Equipment
Elgin Softener Corp.

Boiler Baffle Contractors
King Refractories Co.

Boiler Compound
Dearborn Chemical Co.

Boiler Setting & Walls
Custodis Chimney Cons. Co., Alphons
King Refractories Co.
Lavino & Co., E. J.
Riley Stoker Corp.
Rust Eng. Co.

Boilers, Heating
Babcock & Wilcox Co.
EdgeMoor Iron Co.
Riley Stoker Corp.
Springfield Boiler Co.

Boilers, Power
Babcock & Wilcox Co.
EdgeMoor Iron Co.
Foster-Wheeler Corp.
Riley Stoker Corp.
Springfield Boiler Co.
Union Iron Works
Wickes Boiler Co.

Books
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Breechings
Griscom-Russell Co.

Brick, Fire
Babcock & Wilcox Co.
King Refractories Co.

Brushes, Motor & Generator
U. S. Graphite Co.

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Jeffrey Mfg. Co.
Link-Belt Co.

Buckets, Clamshell
Link-Belt Co.

Buckets, Elevator
Link-Belt Co.
Robins Conveying Belt Co.

Burners, Combined Gas & Oil
National Airoil Burner Co.

Burners, Combined Gas, Oil, Pulverized Coal
Peabody Engineering Corp.

Burners, Gas
National Airoil Burner Co
Peabody Engineering Corp.
Swindell-Dressler Corp.

Burners, Oil
Babcock & Wilcox Co.
National Airoil Burner Co
Peabody Engineering Corp.
Schutte & Koerting

Burners, Powered Coal
Foster-Wheeler Corp.
Fuller Lehigh Co.
Peabody Engineering Corp.
Riley Stoker Corp.

Calcium Carbide
Linde Air Products Co.

Carbic
Linde Air Products Co.

Carbide
Linde Air Products Co.

Car Dumpers, Railroad
Link-Belt Co.

Castings, Brass & Iron
Fuller Lehigh Co.
Link-Belt Co.
Riley Stoker Corp.

Cement, Fire Brick
Babcock & Wilcox Co.
King Refractories Co.
Lavino & Co., E. J.

Cement, Iron
Smooth On Mfg. Co.

Cement, Pipe Joint
Crane Co.
Smooth On Mfg. Co.

Chain Drive
Jeffrey Mfg. Co.
Link-Belt Co.
Phila. Gear Works

Clamps, Pipe
Crane Co.
Smooth On Mfg. Co.
Yarnall-Waring Co.

Clutches, Friction
Caldwell Co., W. E.
Link-Belt Co.

Coal Bumper Lining
Waites, Dove, Hermiston Corp.

Coal Crushers
American Pulverizer Co.
Foster Wheeler Corp.
Fuller Lehigh Co.
Jeffrey Mfg. Co.
Link-Belt Co.
Robins Conveying Belt Co.
Strong Scott Mfg. Co.

Coal Handling Equipment
Jeffrey Mfg. Co.
Link-Belt Co.
Robins Conveying Belt Co.

Cocks
Crane Co.
Dart Mfg. Co., E. M.
Lunkenheimer Co.
Nason Mfg. Co.
Reliance Gauge Column Co.

Combustion Control Systems
Hagan Co.

CO_2 Recorders and Flue Gas Analysis Instruments
Foxboro Co.
Hays Corp.

Compressors, Air
Nash Engineering Co.
Penn Pump & Comp. Co.

Compressors, Thermo
Foster Wheeler Corp.

Condensers, Barometric, Combined, Jet, Surface
Buffalo Steam Pump Co.
Elliott Co.
Foster Wheeler Corp.
Kellogg Co., M. W.
Ross Heater & Mfg. Co.
Schutte & Koerting

Controls, Tank Pressure
Fisher Governor Co.

Controls, Vacuum
Fisher Governor Co.

Converters, Rotary
Elliott Co.

Converters, Synchronous
Elliott Co.

Conveying Equipment
Jeffrey Mfg. Co.
Link-Belt Co.
Robins Conveying Belt Co.

Coolers, Generator
Griscom-Russell Co.
Spraco Inc.

Coolers, Oil
Griscom-Russell Co.
Schutte & Koerting

Cooling Towers
Foster Wheeler Corp.
Schubert-Christy Corp.
Seymour Inc., Jas. M.

Couplings, Flexible Shaft, Rigid, Shaft
Jeffrey Mfg. Co.
Link-Belt Co.
Phila. Gear Works
Terry Steam Turbine Co.

Cranes
Link-Belt Co.

Deaerators
Cochrane Corp.
Elliott Co.

Dealers Machinery
(See Searchlight Section)

Desuperheaters
Elliott Co.
Hagan Corp.
Schutte & Koerting
Swartwout Co.

Dies, Pipe
Curtis & Curtis Co.

Doors, Furnace Inspection
United Conveyor Corp.
Springfield Boiler Co.

Dryers, Coal
Fuller Lehigh Co.

Dust Collectors
Buffalo Forge Co.
Riley Stoker Corp.

Economizers
Babcock & Wilcox Co.
Foster Wheeler Corp.
Riley Stoker Corp.

Ejectors
Chaplin Fulton Mfg. Co
Consolidated Ashcroft Hancock Co.
Elliott Co.
Nash Engineering Co.

Enamel
Wailes, Dove, Hermiston Corp.

Engines, Steam
Air Preheater Corp.
Clarage Fan Co.
Elliott Co.

Evaporators
Foster Wheeler Corp.
Griscom-Russell Co.

Exhaust Heads
Burt Mfg. Co.

Expansion Joints
Crane Co.
Foster Wheeler Corp.
Griscom-Russell Co.
Ross Heater & Mfg. Co.
Yarnall-Waring Co.

Extractors, Oil & Grease
Elliott Co.

Fans, Airplane Type
Schubert-Christy Corp.

Fans, Forced & Induced Draft
Air Preheater Corp.
Buffalo Forge Co.
Clarage Fan Co.
Jeffrey Mfg. Co.
Wing Mfg. Co., L. J.

Filters, Feed Water, Pressure, Water
Cochrane Corp.
Crane Co.
Elliott Co.
Griscom-Russell Co.

Filters, Oil
Burt Mfg. Co.
Elliott Co.
Griscom-Russell Co.

Fittings and Flanges
Crane Co.
Dart Mfg. Co., E. M.
Grinnell Co.
Jefferson Union Co.
Kellogg Co., M. W.
Nat'l Valve & Mfg. Co.
Pittsburgh Piping & Equipment Co.
Power Piping Co.
Shaw Co., Benj. F.
Tube-Turns

Fittings, Ammonia
Crane Co.
Greene, Tweed & Co.

Floats
Hercules Float Works
Nicholson & Co., W. H.

Floodlights, Acetylene
Linde Air Products Co.

Flooring, Steel
Dravo-Doyle Co.
Tri-Lok Co.

Floors, Water Cooled
Riley Stoker Corp.

Fuel Oil Systems
National Air Oil Burner Co.
Peabody Engineering Corp.

Furnace Bottoms, Cast Iron Air Cooled
Allen Sherman Hoff Co.
Riley Stoker Corp.

Furnace Linings
American Engineering Co.
Babcock & Wilcox Co.
King Refractories Co.
Lavino & Co., E. J.
Riley Stoker Corp.

Furnace Walls, Water Cooled
American Engineering Co.
EdgeMoor Iron Co.
Foster Wheeler Corp.
Fuller Lehigh Co.
Riley Stoker Corp.
Springfield Boiler Co.

Furnaces, Bagasse & Wood Burning
Riley Stoker Corp.

Gage Glasses
Chesterton Co., A. W.
Diamond Power Specialty Corp.

Gages, Differential, Draft, Liquid, Depth, Pressure
Ashton Valve Co.
Bailey Meter Co.
Bristol Co.
Consolidated Ashcroft Hancock Co.
Foxboro Co.
Greene Tweed & Co.
Hays Corp.
Jenkins Bros.
King-Seeley Corp.
Reliance Gauge Column Co.
Yarnall-Waring Co.

Gas Collectors
Hays Corp.

Gas, Welding
Linde Air Products Co.

Gaskets
Crane Co.
Ferodo & Asbestos
Greene Tweed & Co.
Smooth On Mfg. Co.

Gates, Coal & Ash Bin
Allen, Sherman Hoff Co.
Jeffrey Mfg. Co.
Link-Belt Co.

Gears
Jeffrey Mfg. Co.
Link-Belt Co.
Phila. Gear Works

Generating Sets
Elliott Co.
Moore Steam Turbine Co
Terry Steam Turbine Co.

Generators, Electric
Elliott Co.

Governors, Pressure
Northern Equipment Co.
Swartwout Co.

Governors, Pump
Atlas Valve Co.
Bailey Meter Co.
Chaplin Fulton Mfg. Co
Fisher Governor Co.
Mason Regulator Co.
Northern Equipment Co.
Squires Co., C. E.

Graphite
Greene Tweed & Co.
U. S. Graphite Co.

Grates
Babcock & Wilcox Co.
Neemes Foundry
Riley Stoker Corp.

Grating
Dravo-Doyle Co.
Tri-Lok Co.

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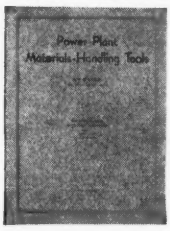

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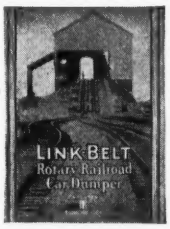

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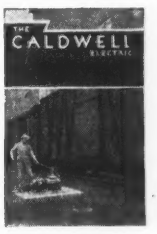

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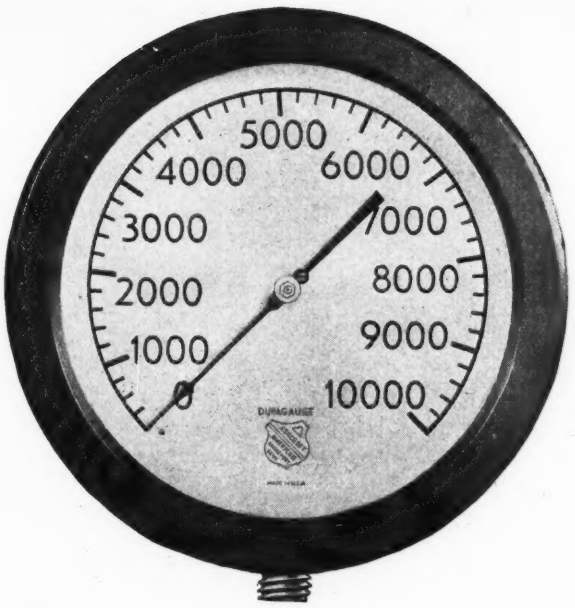

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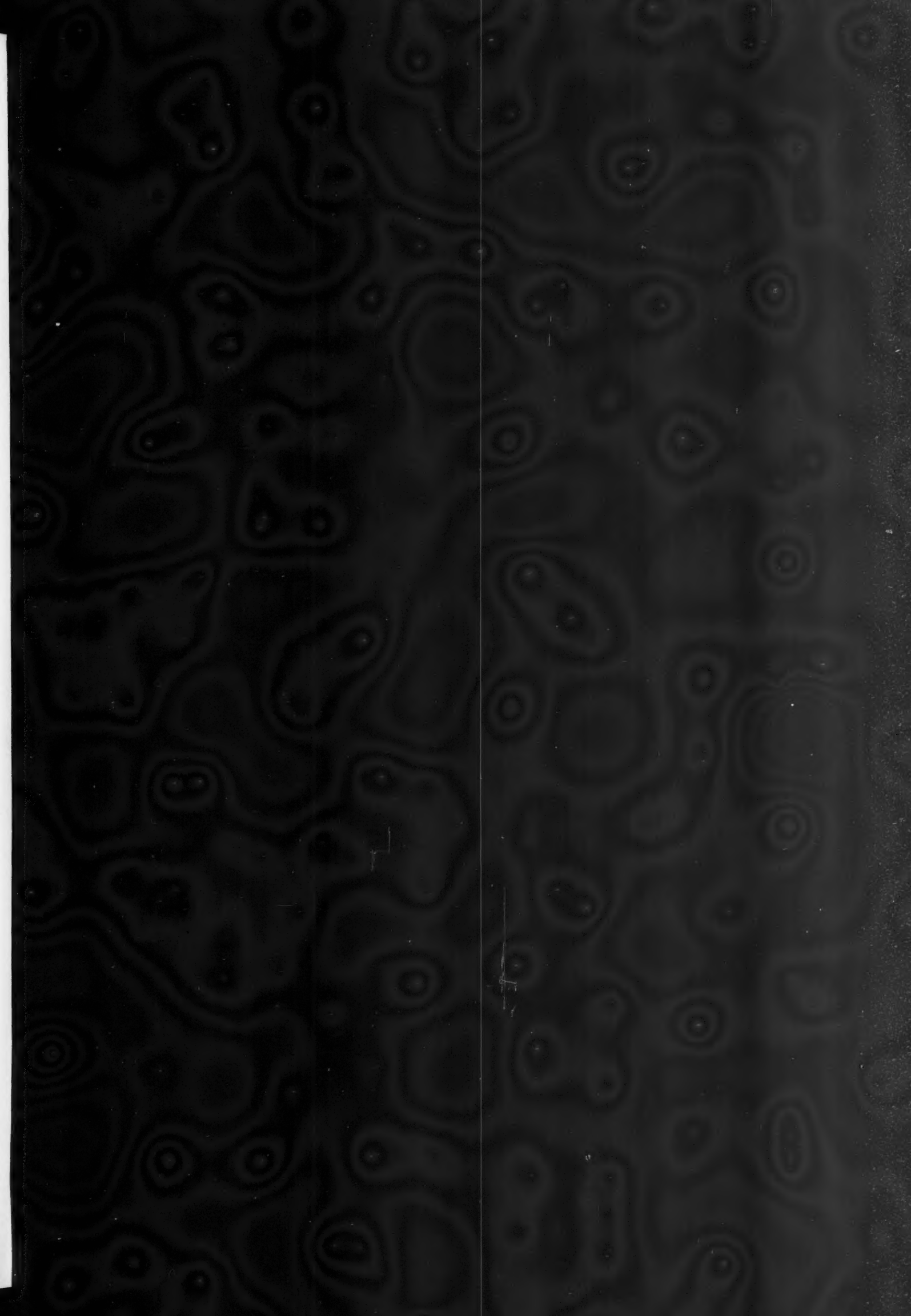
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